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IDA PAPER P-2457

A SURVEY OF TECHNICAL STANDARDS FOR COMMAND AND CONTROL INFORMATION SYSTEMS

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Sarah H. Nash
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Richard L. Wexelblat, *Task Leader*

September 1991

92-15378

Prepared for
Defense Information Systems Agency

92 6 12 038

Approved for public release, unlimited distribution: 27 February 1992.

INSTITUTE FOR DEFENSE ANALYSES
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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
September 1991

3. REPORT TYPE AND DATES COVERED
Final

4. TITLE AND SUBTITLE
A Survey of Technical Standards for Command and Control Information Systems

5. FUNDING NUMBERS
MDA 903 89 C 0003
Task T-S5-771

6. AUTHOR(S)
Sarah H. Nash, Robert P. Walker, Kevin J. Saeger

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses (IDA)
1801 N. Beauregard St.
Alexandria, VA 22311-1772

8. PERFORMING ORGANIZATION REPORT NUMBER
IDA P-2457

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
JIEO/TVCF
Defense Information Systems Agency
Center for C3 Systems
3701 N. Fairfax Dr.
Arlington, VA 22203

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, unlimited distribution: 27 February 1992.

12b. DISTRIBUTION CODE
2A

13. ABSTRACT (Maximum 200 words)

This paper identifies the technical standards required to support future implementation of the Worldwide Military Command and Control System Automated Data Processing Modernization (WAM) target architecture. It is part of a larger task from the Defense Information Systems Agency, formerly the Defense Communications Agency, to describe the WAM target architecture at a level of technical detail necessary for implementation planning. It surveys existing and planned international, U.S. voluntary, and U.S. Federal Government standards appropriate to the seven generic command and control information system (CCIS) services: data exchange, data management, network, operating systems, programming, security and Open Systems Interconnection (OSI) systems management, and user interface. The paper provides a framework of standards to promote interoperability, assure flexibility, and growth potential, and allow for technology insertion through the use of commercial off-the-shelf (COTS) products.

14. SUBJECT TERMS
Standards; WWMCCS; WAM; Architecture; Interoperability; Command and Control Information System (CCIS).

15. NUMBER OF PAGES
676

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

UNCLASSIFIED

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Availability Codes
Dist | Avail and / or Special
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September 1991

Approved for public release, unlimited distribution: 27 February 1992.

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Contract MDA 903 89 C 0003
Task T-S5-771

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PREFACE

This paper communicates the results of a survey of technical standards for Command and Control Information Systems. It fulfills one objective of Task Order T-S5-771, Amendment No. 4, *WAM Target Architecture:*

> "The command and control information system (CCIS) will be defined on accepted and evolving standards that foster interoperability and evolvability, and allow for technology growth with commercial, off-the-shelf (COTS) products and non-developmental items (NDI). Standards include Military and Federal standards as well as American (ANSI and IEEE) and International (ISO and ECMA) standards."

This document has derived much of its source material on the status of standards from Working Paper (WP) 25 of the Army Tactical Command and Control Information System (ATCCIS). ATCCIS is a SHAPE-sponsored program focused on achieving interoperability of land warfare systems in the year 2000 and beyond. The July 1989 version of ATCCIS WP 25 was reviewed by the Military Communications-Electronics Board (MCEB) in September 1989. Edition 2 (August 1990) was distributed to the NATO nations and interested standards bodies in September 1990.

This document has been reviewed by the following members of the Institute for Defense Analyses (IDA): Dr. Tom Bartee, Mrs. Audrey Hook, Mr. Terry Mayfield, Dr. Larry Reeker, and Mr. Phil Walsh. An external review was also performed by Mr. David Howe.

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1. USERS' GUIDE

1.1 Introduction

This paper surveys existing and emerging technical standards applicable to Command and Control Information Systems (CCIS). It is part of a larger task from the Defense Information Systems Agency (DISA) [formerly the Defense Communications Agency (DCA)] to describe the WAM target architecture at a level of technical detail necessary for implementation planning.

1.2 Purpose

This paper identifies technical standards that implement the OSI (Open System Interconnection) model and support application program portability and defines interfaces among modules in a distributed computing environment. It is from these standards that the target architecture for a generic CCIS will be constructed. In this paper, existing and planned standards appropriate to generic CCIS services are surveyed to the level of detail necessary to confirm a reasonable basis for the future support of the WAM architecture. Relevant standards are identified, but no recommendations for selecting standards are considered. Gaps in current and planned standards coverage are identified. This document is intended to serve as a reference to be used in the construction of the target architecture description.

1.3 Scope

This paper contains information on existing and planned international, U.S. voluntary, and U.S. Federal government standards that are potential candidates for inclusion in a generic CCIS target architecture. It is primarily concerned with standards that promote interoperability and portability, assure flexibility and growth potential, and allow for technology insertion through use of commercial off-the-shelf (COTS) and nondevelopmental items (NDI). The paper identifies relevant standards and gaps in current and planned standards coverage that may require development effort. For example, some known WAM requirements that can be matched with standards are listed in Table 1. It does not, however, provide a detailed evaluation of the standards based on WAM requirements. IDA Paper P-2490 [Wexelblat et al. 1991] will provide such analysis and selection.

Table 1. WAM Requirements and Applicable Standards

Requirement	Standard	Section
Intrasite communications	International Organization for Standardization (ISO) Open System Interconnection (OSI) communications protocols (ISO 7498, et al.) and the U.S. Government Open Systems Interconnection Profile (GOSIP) (FIPS 146)	6.2.1 6.4.3
Intersite communications	Development of an interface to an integrated Defense Data Network and the promulgation of a LAN (local area network) standard	6.3.8.1
Hardware independence	POSIX (Portable Operating System Interface for Computer Environments) standards (IEEE P1003)	7.2.1
System software independence	POSIX (IEEE P1003) and Ada (ANSI/MIL-STD-1815A)	7.2.1 8.2.1
Vendor-independent, modifiable, maintainable and portable software	Ada (ANSI/MIL-STD-1815A) (as an implementation and program design language)	8.2.1
Prototyping and incremental migration of software to Ada	Defense System Software Development Standard (DoD-STD-2167A) and DoD Automated Data System (ADS) Documentation Standard (DoD-STD-7935A)	8.3.5
Standard database management facility	SQL (FIPS-127-1) with Ada bindings in order to port relational databases quickly from PC (personal computer) to minicomputer to mainframe, or to database machine, without modifications to query packages or basic database structure; Information Resource and Dictionary System (IRDS) (ANSI X3.138-1988, DIS 10728); and Remote Data Access (RDA) (ISO DIS 9579)	5.2.2.2 5.2.4 5.2.3
Multilevel security	Trusted Computer Evaluation Criteria (TCSEC) (DoD Directive 5200.28)	9.2.4.6

1.4 Information Sources

This assessment is based primarily on a review of standards for open systems developed by the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telegraph and Telephone Consultative Committee (CCITT). The United States participates in ISO through Accredited Standards Committee (ASC) X3, Information Processing Systems.

Since ISO/IEC has decided to use the standards profiles being developed by international regional standards workshops, the primary sources for profiles are those workshops. NATO's Tri-Service Group on Communications and Electronics (TSGCE)

[formerly the Tri-Service Group on Communications and Electronic Equipment (TSGCEE)] Subgroup 9 (SG9) on Data Processing and Distribution is currently the focus of standards efforts for use of open systems in international military systems. Thus, TSGCE SG9 draft standardization agreements (STANAGs), *NATO Technical Interface Standards (NTIS) Transition Strategy* [NATO 1989], and working documents, together with U.S. initiatives, form the basis of the assessment of military use of open systems standards for applicability to the WAM target architecture.

The cutoff date for information contained in this paper is August 1991. The primary impact of this cutoff is that the progression of some ISO standards to committee draft (CD), draft international standard (DIS), and international standard (IS or ISO) status may not be fully reflected herein.[1]

1.5 Structure of the Paper

This chapter assists the reader in navigating the document and understanding the information presented in it. Chapter 2 describes the background to the WAM task, the methodology used to identify and analyze standards relevant to WAM, and gives an introduction to the standards process. Chapter 3 provides an overview of the assessment and includes a description of the reference model for OSI that is the basis for most of the current international data communications standards activities. It also addresses military requirements for OSI. The final sections of Chapter 3 discuss technical standards for applications portability including some of the profiles recommended by international and national standards bodies for applications portability and interoperability of similar products by different vendors.

The standards are reviewed separately for each of the seven service areas: data exchange standards (Chapter 4), data management services (Chapter 5), network services (Chapter 6), operating system services (Chapter 7), programming services (Chapter 8), security services and OSI systems management (Chapter 9), and user interface services (Chapter 10). Figure 1 identifies the role of each chapter. Chapters 2 and 3 are essential to understanding the assessment, but the remaining chapters are generally independent and can be read in any order. Chapters 4-10 address the seven groups of standards for the WAM Architecture.

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1 While the status of emerging standards is continually changing, this paper records the standards actions taken at the June 1991 ISO/IEC Joint Technical Committee 1 Subcommittee 21 (JTC1/SC21) Plenary Meeting in Arles, France.

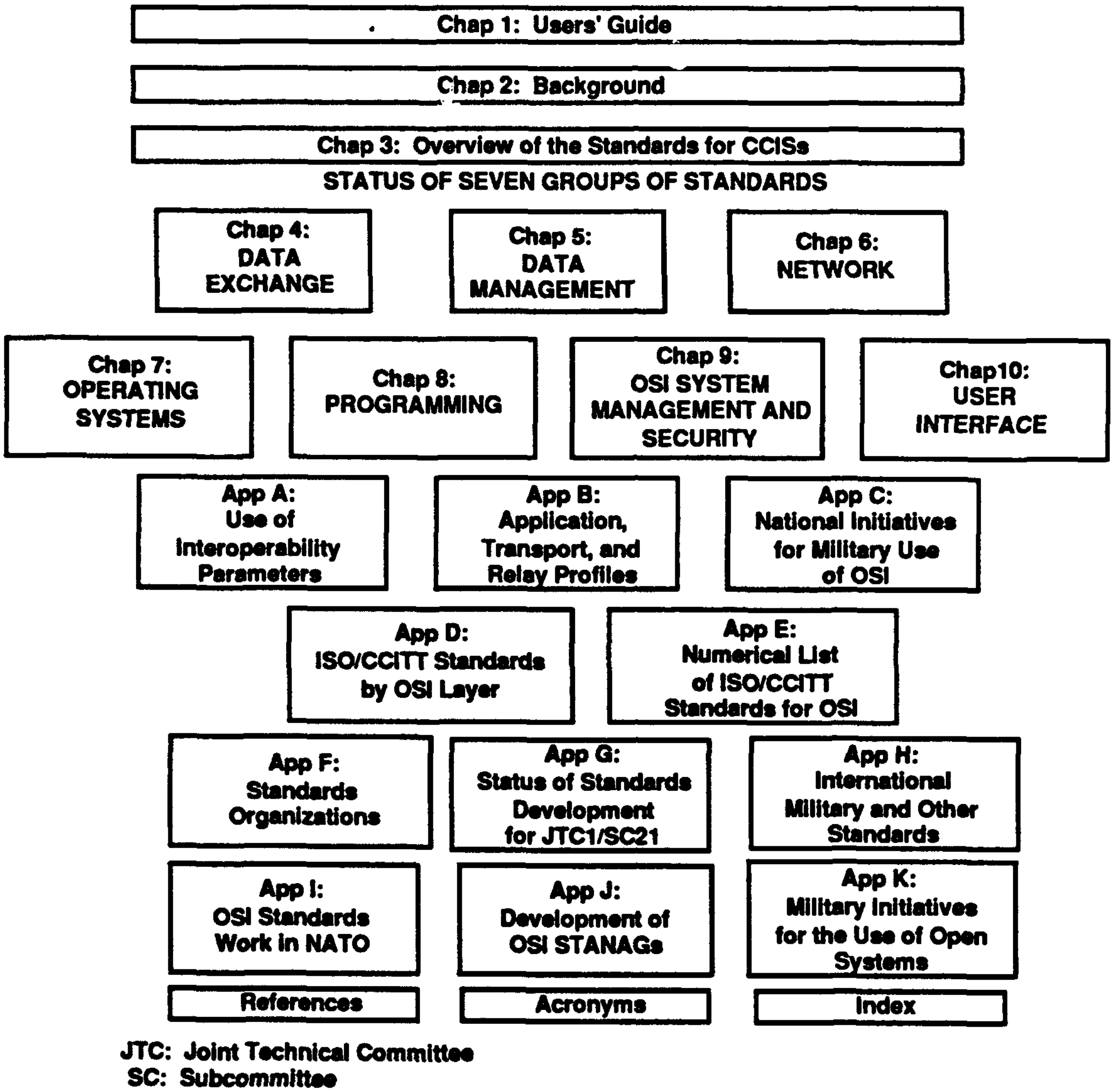

Figure 1. Organization of the Analysis of Technical Standards for WAM

Several appendixes are provided as reference material. Appendix A expands the discussion of the interoperability parameter methodology and applies the approach to some commonly used standards (RS-232, RS-423, STANAG 4202, and CCITT X.25). Appendix B summarizes the application, transport, and relay functional profiles using examples identified for use in NATO. Appendix C provides examples of TSGCE SG9 and national initiatives to address the military use of OSI standards. A compilation of technical standards being developed by ISO and CCITT is given in Appendixes D and E, the former listed by layer of the OSI Reference Model and the latter listed numerically. Appendix F identifies the role and (in some cases) the standards responsibility of international and national standards bodies, both civil and military. Appendix G provides some detailed

information on the work plans for one of the major subcommittees (SC21) of the Joint Technical Committee Number 1 (JTC1) of ISO and IEC. Appendix H identifies STANAGs and other military and commercial standards being developed for use in open systems. A detailed review of the work of TSGCE SG9 is provided in Appendix I and the NATO OSI data communication STANAGs in Appendix J. Appendix K provides a review of the plans by military bodies to specify standards and military enhancements to international commercial technical standards for OSI.

References cited in the paper appear in the References section in alphabetical order. A List of Acronyms defines acronyms used in the paper. An Index provides subject access to the information in the paper.

1.6 Locating Standards

Standards can be located through the index or through the table of contents. In addition, several appendixes supplement the information in the index and table of contents.

Users who know the subject area to which the standard belongs, or are interested in learning about all of the standards in a particular subject area, can use the table of contents as a guide. Users knowing only a standard number or name will need to use the index and perhaps one or more of the following appendixes.

Appendix D lists the international standards (ISO, NATO, and CCITT) by OSI layer.

Appendix E is a numerical listing of ISO standards, working drafts, technical papers, new work items, and CCITT recommendations relevant to CCISs, and will help the user who has only an ISO or CCITT standard number. The ISO standards are listed first, followed by working drafts, technical papers, and new projects (formerly called new work items). Technical papers and new projects typically begin SC 6 N XXX (Subcommittee 6, Telecommunications and Information Exchange Between Systems), SC 21 N XXXX (Subcommittee 21, Info Retrieval, Transfer, and Management for OSI), JTC1 N XXX, or SGFS N XXX (ISO/IEC JTC1 Special Group on Functional Standardization). The listing of CCITT recommendations concludes Appendix E.

Appendix H lists the NATO STANAGs and other NATO documents, U.S. Military Standards, Agreements from Regional Workshops, U.K. British Standards Institute Standards and Papers, and U.S. Voluntary Standards and Papers in numerical order.

Entries in the index generally are made using acronyms, not the full spellings. If the acronym has not been used in the document, it will not be in the index. In such cases it is best to check for the full name. The list of acronyms, which follows the appendixes and precedes the index, gives full names of acronyms. While some subject entries are included in the index, most are proper nouns of such entities as systems, standards, programs, organizations, and standards committees. Entries in the index refer the user to specific sections of the document, not page numbers.

Once a subject or standard has been located within the document, the user can learn what standards exist, which ones are emerging in various subject areas, and what the major issues are surrounding these standards. Also provided are a short description of what the standard does, who is responsible for developing it, its standard number, and its status as of August 1991. Standards are linked to CCIS requirements where these requirements are known.

2. BACKGROUND

2.1 Background from 1989 Decision Coordinating Paper for WAM

Initially implemented in the early 1970s as 35 stand-alone systems, the WWMCCS Automated Data Processing (ADP) System architecture has evolved into a networked system that supports intersite communications and a limited number of networked applications. In 1981 the Deputy Secretary of Defense assigned the Air Force as the Executive Agent for the task of modernizing the WWMCCS Standard ADP System and the Air Force established the WWMCCS Information System (WIS) Joint Program Management Office. In 1989 the program Executive Agency transferred from the Air Force to DISA and DISA developed a new modernization strategy under the name of WAM.

The WAM strategy is one of incremental improvements that makes use of commercial off-the-shelf and nondevelopmental items. Services and Agencies will develop their own applications, with DISA providing the guidelines, architecture, and infrastructure to integrate these applications into a single system.

Using standards will enable the interoperability between systems and portability between different computing environments necessary for the WAM strategy's success. For example, intersite communications will be provided via the Defense Data Network (DDN) and will be based on OSI communications protocols. Additionally, adherence to the POSIX standards for operating system interfaces for the standard applications, coupled with the use of the Ada programming language (as an implementation and program design language), will allow the portability of application software to faster and more cost-effective processing environments without the extremely high costs normally associated with this transition. These improvements, leading to an open systems architecture, have the additional benefit of affording ease of use.

The November 1989 WAM Decision Coordinating Paper identifies the following features that will be required in the WAM [DCA 1989]:

- Migrate from the WMMCCS Intercomputer Network (WIN) unique protocols to network standards of ISO.
- Comply with the U.S. GOSIP.
- Use a standard database management facility.
- Move to standard data elements.
- Use Ada for applications software.

- Ensure maximum isolation of applications from underlying hardware and system software.
- Obtain vendor-independent, modifiable, maintainable, and portable software.
- Ensure user friendliness.

2.1.1 Basic Services

Seven basic services are being used to describe the CCIS target architecture. The seven services are derived from the Application Portability Profile (APP) services proposed by the National Institute for Standards and Technology (NIST). A difference is that the NIST APP counts Graphics but not Security among the seven services. The generic CCIS includes Graphics in the User Interface Service and treats Security as a Service area.

CCIS Services	NIST APP Services
Data Exchange	Data Interchange
Data Management	Data Management
Network	Network
Operating Systems	Operating Systems
Programming	Program
Security and OSI System Management	
User Interface	User Interface
	Graphics

The WAM target architecture is defined in terms of the services to be provided by a CCIS in the 1995-1997 time frame. As a minimum, these services provide two capabilities: (1) the mechanisms necessary to exchange information in a way that preserves meanings and relationships (termed *basic interoperability*[2]) and (2) implementation-independent interfaces to ensure a high degree of applications portability.

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2 The NIST APP defines interoperability as the ability to have applications and software operating on heterogeneous hardware/software platforms cooperate in performing some user function. The *Department of Defense Dictionary of Military and Associated Terms*, Joint Pub 1-02 (formerly JCS Pub 1), 1 December 1989, offers two definitions for interoperability. The first, from the *NATO Glossary of Terms and Definitions* is "The ability of systems, units or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together." The second definition is "The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users." The degree of interoperability should be defined when referring to specific cases.

The WAM target architecture is required to support interoperability with tactical, theater, strategic, and sustaining base systems. The Architecture is intentionally generic and not constrained by the current systems. Examples of such systems are provided in Appendix K for reference purposes.

The initial architectural approach for WAM identifies seven major services:

a. Data Exchange Standards. Provide the ability to transfer data that represents abstract objects such as military orders, reports, research documents, graphical items (e.g., maps, overlays, symbolic graphical data that might be produced by a simulation), and raw video (e.g., television images). Data exchange services also address product descriptions. Data exchange services permit the exchange of data among applications and between systems so that the meaning and relationships in that data are preserved.

b. Data Management Services. Provide for data processing functionality and support of data objects. Data management services address data dictionary, directory, query, and reporting. These services support the storage, control, distribution, management, and allocation of simple data such as text and numeric information and complex items such as complete documents, maps, charts, images, and multimedia objects.

c. Network Services. Include the transmission and interface standards and protocols that support logical and physical communication. They describe and constrain how the hardware and software of the nodes cooperate in node-to-node interaction.

d. Operating Systems Services. Manage hardware and software resources and all software interfaces, including local and distributed execution of application programs. Standards in this domain include those that cover program-to-program communication and synchronization as well as management of memory and interfaces to network and data management services.

e. Programming Services. Affect two aspects of the CCIS: application development and the execution of applications. In the former case, programming services support the development, checkout, installation, maintenance and testing of application and system software. At present there are few standards to support this domain although work on software engineering environments, specification languages, and program development and, maintenance tools is moving toward the stage when standardization is likely. In the latter case, the architectural role of programming services is in the language-specific and inter-language interfaces that support the client-server interaction.

f. Security Services. Protect the components, mechanisms, and information of the CCIS. Basic security functions include authentication, access control, confidentiality, integrity, and nonrepudiation. This chapter also addresses standards pertaining to OSI system management, conformance testing, and registration authorities.

g. User Interface Services. Support visual and functional interaction with the user, providing access to hardware and software and graphical user interface (GUI). They control the presentation of data and mode of interaction.

2.1.2 Features of the Architecture

The WAM target architecture applies to CCISs that, among other things, are transaction processing systems with partitioned, partially replicated databases capable of supporting applications and maintaining the capability for consistent interpretation of the data across organizational boundaries.

The target architecture will be defined using existing or emerging standards wherever possible. This paper identifies standards (and options within standards) that are applicable to each group of services, but the paper does not recommend any specific standard or groups of standards.

2.2 Methodology

This section describes the methodology employed to identify the group of existing and planned standards required to support CCIS functionality and to assess the completeness of standards coverage for the 1995-1997 time period of the target architecture. The methodology, which emphasizes the requirements for interoperability, is illustrated in Figure 2.

The methodology has three major steps. First is a review of the services required for WAM in each group of standards. Second is identification of all the technical standards, stacks (ordered groupings), and profiles developed or emerging from international and national standards bodies. Third is an analysis of the status of those standards and identification of the options and, in some cases, interoperability parameters for these standards. Where possible, deficiencies in the standards are identified and discussed.

2.2.1 Identification of Standards, Stacks, and Profiles

Following a review of the required services for each group of standards is the identification of the appropriate base standards. These standards may come from international, NATO, national military, or national non-military standards bodies, and they may be existing or planned. High-level options within standards applicable to CCISs are identified.

For many functions, there are several interrelated standards that must be used together to provide the required services. In most cases there is an order or hierarchy among these standards in which the lower levels are closer to physical means, and higher levels are associated with applications that are independent of the physical means. An ordered grouping of standards is called a stack. A profile[3] is a stack of standards for which the interoperability parameters are partially or fully specified (profiles usually represent agreements among implementors).

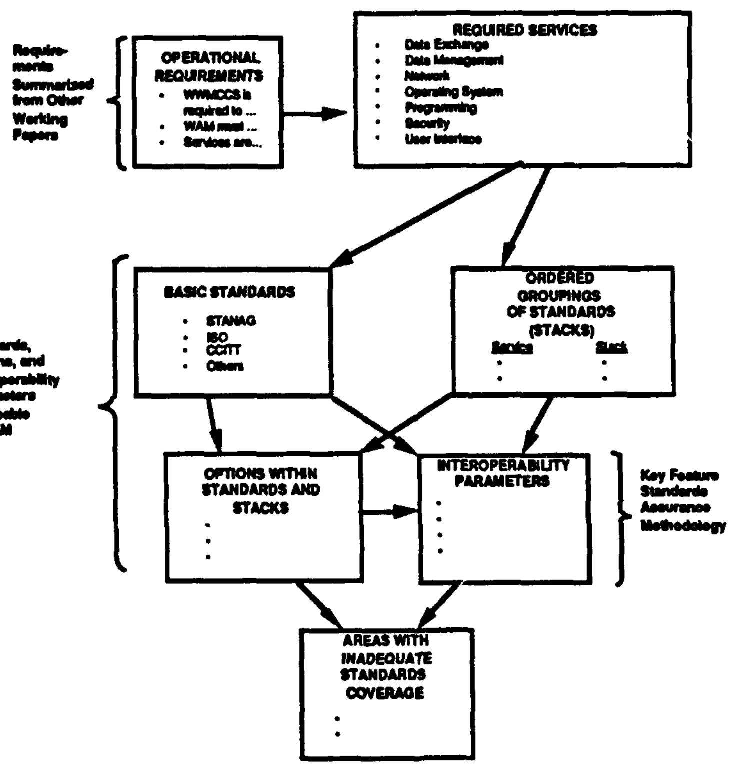

Figure 2. Overview of the Methodology

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3 ISO/IEC JTC1 defines profile as a set of one or more base standards and where applicable, the identification of chosen classes, subsets, options, and parameters of those base standards necessary for accomplishing a particular function.

2.2.2 Approach to the Analysis

Analysis of the standards is addressed in three ways. The first step is to check that there are standards that generally support each specific WAM class of service. On a more specific level, a methodology for ensuring adequate standards coverage through detailed analysis has been developed. An interoperability parameter approach is defined that begins with the identification of the system design parameters whose control is required to achieve interoperability. The assembled parameters act as a checklist for interoperability since each interoperability parameter must be controlled by a suitable standard. The purpose of an analysis using interoperability parameters (the second step) is to recognize and examine all relevant quantities and characteristics in a direct manner, instead of assuming that existing or draft standards will provide adequate coverage of the quantities. Appendix A discusses this approach in more detail. A format called a standardized profile is being used by the NIST OSI Implementor's Workshop, ISO, and NATO for specifying stacks and interoperability parameters. Standardized profiles are discussed in Section 6.4, and examples are provided in Appendix B.

In the third step of the coverage analysis, the array of standards identified that could support WAM is compared with plans for near-term efforts to check for completeness. Near-term efforts include the standards and stacks recommended by several national agencies, such as government open systems interconnection profiles and applications portability profiles recommended by NIST and international consortia such as X/Open. Military initiatives are reviewed in Appendix C, Appendix I, and Appendix K. In addition to providing a check on completeness of applicable standards, some of these near-term efforts are of interest because they provide a basis for transition strategies for moving to open environments for information processing and exchange.

2.2.3 Limitations on the Role of Standards

Use of standards, together with the appropriate control of interoperability parameters within the standards, has the potential to achieve the required interoperability and portability of CCISs applications at a substantially reduced cost when compared with the use of military-unique specifications. Many aspects of the target architecture may be eventually expressed through selection of standards. However, the groups of standards applicable to CCISs have changed rapidly over the last five years and are likely to continue to change for several reasons. The changes may be due to wider acceptance of one technical approach over other competing approaches, leading to international

standardization of that approach. The changes may also occur as a natural process of stabilization and maturization of new models and understanding of the required services. In addition, changes may occur as a result of the introduction of new technology, such as high data rate local area networks. Finally, some standards will fall out of use as they are replaced by others that give better performance for CCISs. To adapt to the changing nature of CCIS standards, CCIS architectures must be flexible and not constrained to the standards mature and available at a specific time.

2.3 Overview of the Standards Development Process

This section provides a summary of standards. It describes the role of standards, standards organizations, and the process by which standards are developed. It also gives information on ordering standards and updating their status. More information can be found in the following references: [NATO 1989; Stallings 1985; Stallings 1987; SC21 N 4911 1990; Rose 1990; INI 1987; Army 1989; and SPAG 1987].

2.3.1 Role of Standards

Standards convey information; their implementation can assure compatibility, reduce variety, and establish minimum levels of quality and reliability. Moreover, they can be categorized by type: interface, process, or product. Interface standards are the least restrictive and merely define certain characteristics. Process standards, while somewhat more restrictive, define the manner in which a process is performed, but do not determine the actual output. Product standards, since they define a particular output or outcome, tend to be the most restrictive. These categories also indicate the likely effects of a particular standard (or function of a standard) in terms of whether certain groups may resist the standard and how well the standard will be integrated into the technology life cycle. For example, a product standard promulgated too early in the technology life cycle may be resisted and not implemented by industry because it does not allow enough flexibility in adapting to anticipated changes in the technology. Conversely, simple interface standards may be insufficient for users or maintainers of a product who require accurate or detailed information about a particular product and how it functions [Putnam 1982].

In the case of WAM, standards will be used to achieve interoperability and increase portability so that the variety of COTS products can be increased. Therefore, most of the standards described in this document are interface standards. However, merely specifying standards will not necessarily yield interoperability. The standards must be accepted and to

be accepted they must be correct and reflective of the state of practice. Moreover, many standards have options. To be interoperable, two systems using the same standard must have selected the same options and other types of interoperability parameters from a predefined standards profile. For example, the U.S. GOSIP recommends certain standards and options for U.S. Government implementations of the OSI, but many implementation parameters are not addressed. Moreover, many predefined standards profiles can be developed from the U.S. GOSIP suite of standards and options.

The NIST APP is an approach to identifying standards that could be used to achieve an open environment that would ensure a high degree of applications portability. In addition to the operating system, this environment includes data management, data interchange, network services, user interface, graphics services, and programming services. Security and System Management Services underlie the seven basic services since they are integral to them all. Efforts are still required to specify the appropriate standards and "bindings" for the open environment. The complete APP proposed by NIST, together with the status of relevant standards other than POSIX, is discussed in Section 3.4.3.3.

Reference models are developed to provide a common framework for different standards and protocols. For example, the OSI comprises many standards, but the OSI Reference Model divides the scope of OSI standards into seven layers, showing what function each performs and how they interact. The reference model also indicates the model's relationship to other models and addresses issues that cut across several models.

A communications architecture is similar to a reference model, but is at a higher level. An architecture determines which services are required to perform the overall goals of an information system. The standards, protocols, and reference models work in harmony to perform these services.

2.3.2 Standards Organizations

This section discusses the organizations that produce standards. Section 2.3.3 discusses organizations that produce standardized profiles for open systems.

Standards come from various national and international sources including industry, the U.S. government, and international organizations. Of particular interest are those organizations developing standards within the context of the OSI Reference Model. A few of the important U.S., international, and military standards organizations are included in

this section to acquaint the reader with the scope of their standards-making activities. Appendix F is a more complete listing.

2.3.2.1 International Sources

Several international organizations are involved in the promulgation of standards. Two that are particularly relevant to computers and information technology are the ISO and the IEC. The ISO/IEC JTC1 is charged with international standardization of information technology systems [Cargill 1989, 126]. In addition, the CCITT and NATO issue recommendations and standardization agreements, respectively.

2.3.2.1.1 International Organization for Standardization (ISO)

The development of an ISO standard, from first proposal to actual publication of the standard, is an arduous and time-consuming process, which ensures that the final result is acceptable to as many countries as possible. Figure 3 is a flowchart of the process. The process begins when a member body submits a proposal for a new work item (NWI). The introductory proposal is assigned to a Working Group (WG) of a Technical Committee (TC) or Subcommittee (SC), which will be responsible for progressing the document through the standardization process. In this initial stage, the proposal is called a working draft (WD). The appropriate working group (WG) of the assigned technical committee (TC) publishes the WD in the form of a committee draft (CD). Prior to February 1990, this was known as a draft proposal (DP). This CD is then circulated among interested members for balloting and commenting. If the CD obtains substantial support, it is then circulated as a draft international standard (DIS) for a six-month balloting period. If the DIS receives a majority approval by the TC members and 75 percent approval from all voting members, it is advanced to the Central Secretariat. If the balloting of the DIS is negative, the DIS is demoted to CD status and work continues on building consensus. The Central Secretariat submits the approved DIS to the ISO Council, the board of directors of ISO. The council accepts the DIS as an international standard (IS)[4], and finally, ISO publishes the international standard.

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4 ISO is often used to denote an international standard adopted by ISO or jointly by ISO/IEC.

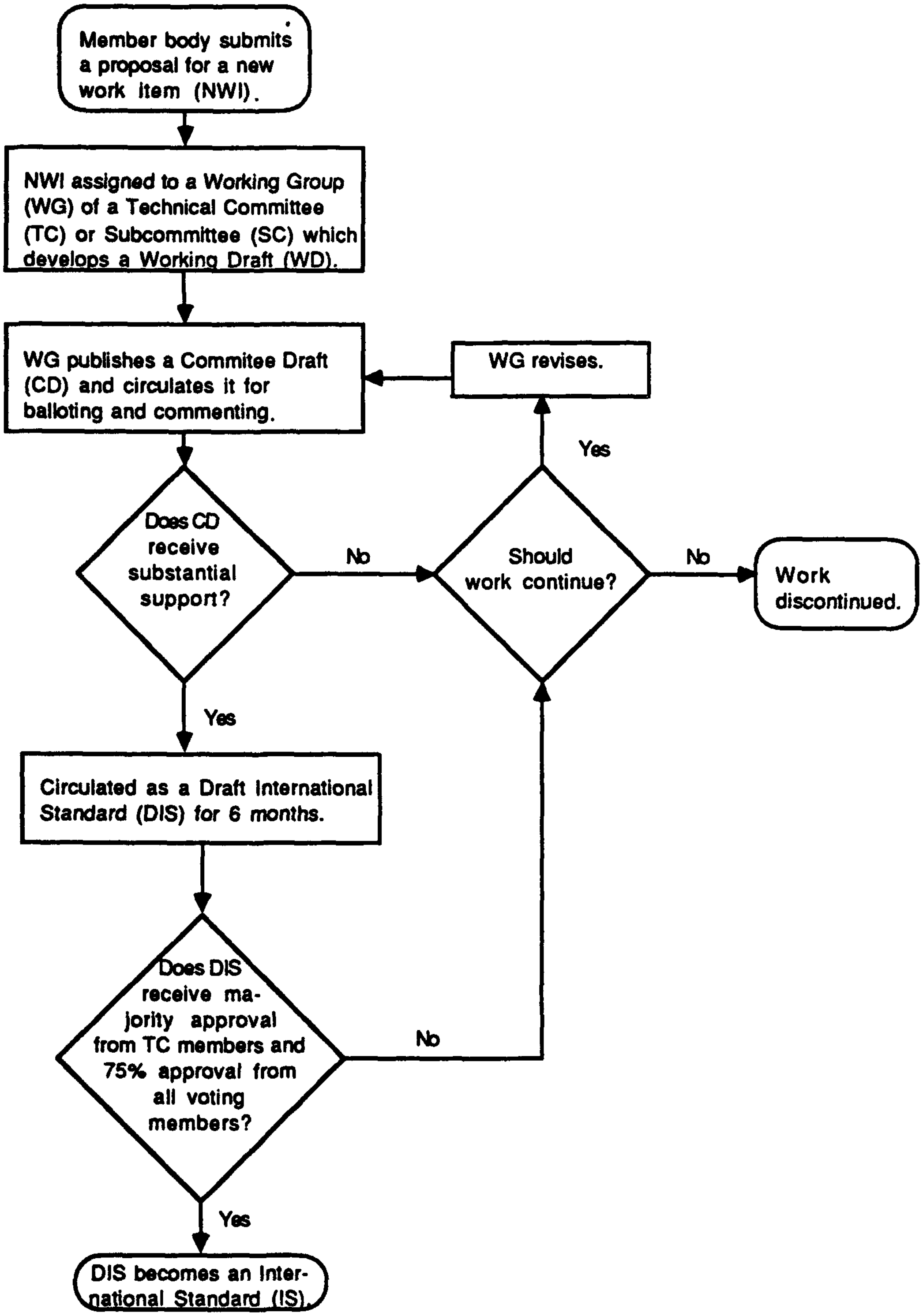

Figure 3. Flowchart of the ISO Standardization Process

A standard that has achieved DIS status is considered to be stable. Only minor changes are made to a DIS draft prior to becoming an international standard. If it is

necessary to modify a standard, there is an addendum process: working draft addendum (WDAD), committee draft addendum (CDAD) [formerly proposed draft addendum (PDAD)], draft addendum (DAD) with DIS status, and finally, an addendum (AD) with international standard status. A similar process [working draft amendment (WDAM), draft amendment (DAM), and amendment (AM)] is used for amendments. In addition, technical corrigenda may be approved to correct technical errors that do not affect the intended standardization.

The ISO/IEC JTC1 SGFS is developing standards for International Standardized Profiles (ISPs). As such, they bear an ISP prefix in lieu of the traditional ISO prefix although their numbers follow the ISO numerical sequence. ISP designations are pDISP for proposed draft ISP and DISP for draft ISP.

2.3.2.1.2 International Organization for Standardization and International Electrotechnical Committee (ISO/IEC)

ISO/IEC, a voluntary, nontreaty organization, develops standards in many areas. Founded in 1946, this organization promotes the development of standardization and related activities that facilitate the international exchange of goods and services.

The members of ISO/IEC are organizations chosen by the participating nations and nonvoting, observer organizations. Most ISO/IEC members are governmental standards institutions or organizations incorporated by public law. The United States member body is ANSI.

ISO/IEC is organized, under the administrative arm of the Central Secretariat, as a group of technical committees chartered to produce standards in various areas. The committee most relevant to this work is Technical Committee 97 (TC97), Information Processing Systems. TC97 is organized into subcommittees and working groups that actually produce the standards. The work related to OSI is carried on by subcommittees SC6 and SC21. More specifically, the working groups (WGs) of prime interest are:

- SC6. Telecommunications and Information Exchange Between Systems
  - WG 1. Data Link Layer
  - WG 2. Network Layer
  - WG 3. Physical Interface Characteristics
  - WG 4. Transport Layer
  - WG 5. Architecture and Coordination of Layers 1-4.

- SC21. Information Retrieval, Transfer, and Management for OSI
  - WG 1. OSI Architecture
  - WG 3. Database
  - WG 4. OSI Management
  - WG 5. Specific Application Services and Protocols
  - WG 6. Session, Presentation, Common Application Service Elements, and Upper Layer Architecture.
  - WG 7. Open Distribution Processing.

2.3.2.1.3 International Telephone and Telegraph Consultative Committee (CCITT)

CCITT is a committee of the International Telecommunications Union (ITU), a United Nations treaty organization. CCITT is chartered to study and issue recommendations on technical, operating, and tariff questions relating to telegraphy and telephony. The primary objective of the organization is to standardize techniques and operations in telecommunications to achieve end-to-end compatibility of international telecommunication connections.

The members of CCITT, because it is a committee of a treaty organization, are governments. The representation for the United States is from the Department of State. Normally, the members of the CCITT are the national Post, Telephone, and Telegraph administrations. CCITT is organized into 15 study groups (SGs). There are three areas of activity concerned with OSI matters: data communications, telematic services, and integrated services digital networks (ISDNs). Work in CCITT is focused on specific formal questions posed at the beginning of the study period. In the three areas concerned with OSI matters, the work directly involves six SGs:

- SG I. Specifies the operational aspects of telematic services.
- SG VII. Specifies interfaces to public data networks, including X.25 and related standards.
- SG VIII. Develops terminal equipment recommendations for the telematic services.
- SG XI. Specifies switching and control signaling for telephony.
- SG XVII. Standardizes data transmission over the telephone network.
- SG XVIII. Standardizes digital networks in general and ISDN in particular.

CCITT produces documents called recommendations, not standards. The term recommendation is used because CCITT recommends that these documents should be implemented. Every four years a Plenary Assembly is held that establishes the work program for the next four years. This work program is composed of questions submitted by the SGs based on requests made by the various member organizations. At the end of the four-year period, each study group prepares draft recommendations in answer to these questions and submits them to the new Plenary Assembly. If the assembly approves these recommendations, the drafts are published as CCITT Recommendations. In urgent situations, the drafts can proceed through a special balloting procedure to become a CCITT Recommendation before the normal four-year period has expired. The new series of recommendations, when published, supersedes the recommendations from all previous study periods. All recommendations produced in the same study period are bound in books of the same color. For example, the 1984 recommendations are known as the "red books," the 1988 recommendations are known as the "blue books," and the 1992 recommendations will be known as the "yellow books." Wherever possible these are adopted as ISO standards.

2.3.2.1.4 Tri-Service Group on Communications and Electronics (TSGCE)

TSGCE develops and maintains standardization agreements (STANAGs) for NATO. TSGCE has a number of subgroups and project groups working on standards. For example, TSGCE SG9 has responsibility for the NATO OSI Reference Model and for developing OSI STANAGs. Appendix F lists the various subgroups and project groups, and includes an organizational chart for NATO bodies in the fields of communication and information systems.

2.3.2.2 U.S. Industry

In the United States, the process of defining standards is voluntary and is coordinated by ANSI. ANSI accredits organizations such as professional and technical societies, trade associations, or consumer and labor groups to develop or adopt standards in various areas. Three types of organizations can create a standard: (1) Accredited Sponsor (AS), (2) Accredited Organization (AO), and (3) Accredited Standards Committee (ASC) [Cargill 1989, 103].

Under the AS method, an organization sponsors a drive for standardization and begins the canvass method by inviting comments on the proposed standard from anyone

who cares or may be materially affected by it. This method is appropriate only when substantial agreement on the document to be standardized already exists, as was the case with the Ada programming language standard [Cargill 1989, 104].

In the AO method, an existing group completes a standard in an area in which it has direct and material interest and a perceived expertise. Usually an industry trade group or association of industry experts or participants, the AO often has extant standards that are based on the methodologies of its profession or discipline [Cargill 1989, 105]. The IEEE Computer Society is an example of an AO.

The ASC takes groups and factions with diverse, even antagonistic viewpoints and melds them into a semicohesive whole, with the aim of engineering a solution that encompasses all of the diversity while maintaining the benefits of individuality. The key to the ASC is the Secretariat, held by a sponsoring organization, which provides legal, administrative, and financial backing [Cargill 1989, 107]. The Computer and Business Equipment Manufacturers Association (CBEMA) is the Secretariat for ASC X3 on Information Processing Systems standards. In addition to developing, reviewing, and approving proposed American National Standards, the ASCs coordinate standardization activities on the international level by participating in the ISO.

An ASC project is assigned an arbitrary project number followed by an alphabetic suffix describing its type:

- S. Study project to determine the feasibility and need for a development project that has been proposed to the ASC.
- D. Development project formally recommended and approved to produce an American National Standard.
- DT. Development project to produce a Technical Report.
- R. Revision project to revise an existing approved American National Standard.
- RF. Reaffirmation project, as a result of the ANSI-required five year review when the Technical Committee recommends that an existing American National Standard be reaffirmed without change.
- M. Maintenance project, the status into which a Development project is automatically placed upon approval of an American National Standard by ANSI.
- L. Liaison project, formal recognition of relations with another standards body on a project for which X3 has no existing standard or work in process.

- I. International Development project, which is intended to result in an International Standard [CBEMA 1989, iv].

2.3.2.3 U.S. Government

The National Computer Systems Laboratory (NCSL) at the NIST contributes to the development of industry-wide standards by leading and participating in the work of organizations such as ANSI, IEEE, and ISO. In addition it develops tests and test methods for new standards. NIST prepares and the Department of Commerce issues Federal Information Processing Standards Publications (FIPS PUBS). Wherever possible, the FIPS are aligned with or identical to ANSI or ISO standards. However, when the government needs a standard, and the industry and its standards groups do not respond to this need, the NCSL has the ability to develop its own FIPS [Cargill 1989, 213].

The Department of Defense (DoD) also issues standards, called MIL-STDs or DoD-STDs, through its Quality Standardization Program. Where there is no substantial or demonstrable advantage to DoD in the development of a new standard, non-Government specifications and standards are to be adopted [DoD 1976, 2]. The DISA is responsible for developing military standards in communications and information technology.

The Center for Information Management (CIM) Infrastructure office within DISA has the responsibility for defining requirements and priorities for standards development. The Protocol Standards Steering Group (PSSG) recommends DoD standards policies to the director of DISA. The Chief of the DISA Office of Interoperability and Standards chairs the PSSG. Other representatives are nominated from the Military Departments, Defense Agencies, Joint Staff, Office of the Secretary of Defense (OSD), Defense Research Advanced Projects Agency (DARPA), National Communications System (NCS), JTC^3A, and NIST. The Data Communications Protocol Standards (DCPS) Technical Management Panel (DTMP) [formerly the Protocol Standards Technical Panel (PSTP)] was formed under the direction of the PSSG to investigate technical matters and develop recommendations for standardization. The focus of the PSTP's work in 1989 and 1990 was developing a military supplement to GOSIP. The report of the PSTP [PSTP 1991] was published on January 8, 1991.

Now a part of DISA, the JTC^3A is the lead agency for tactical communications standards. A new organization within the JTC^3A is the Center for Standards, which centralizes the standards activity of DISA. Two major standards bodies within the Center for Standards are the Joint Message Standards Working Group (JMSWG) and the Fire

Support Subgroup (FSSG). The JMSWG is responsible for Joint Interoperability Tactical Command and Control System (JINTACCS) message text formats (MTFs) and tactical data links. The FSSG has developed a Variable Message Format (VMF) standard for bit-oriented messages expected to be used in fire support. A subordinate group to the JMSWG, the FSSG has recently been given responsibility for joint data communication standards for digital entry devices, such as the Digital Communications Terminal.

The Joint Technical Standards Steering Group (JTSSG) sets policy for and approves the products of the MIL-STD-187 and MIL-STD-188 series standards activities.

2.3.3 Organizations Producing Standardized Profiles

Three international regional workshops have been established to promote OSI. A Regional Workshop Coordinating Committee promotes dialog and harmonization among these workshops. The goal of the workshops is to define standards profiles that will ensure the interoperability of products from different vendors. The European Workshop for Open Systems (EWOS) promulgates harmonized technical proposals for functional profiles of OSI standards and corresponding conformance test specifications. The Asia-Oceania Workshop (AOW) also prepares technical proposals for standardized profiles. The most active participant is Japan. The NIST OSI Implementor's Workshop (NOIW) provides North American input to the standardization of profiles. The recommendations of this workshop form the basis for U.S. GOSIP.

2.3.4 Ordering Standards and Updating Their Status

The status of emerging standards is constantly in flux. Even stable standards can change as they are updated or revised. Therefore, the user must know where to find the most recent information on standards as well as where to find the standard. Below are citations of publications that give the status of existing and emerging standards appearing in this paper as well as ordering information.

2.3.4.1 ISO

The *ISO Technical Programme*, published in January and July, lists CDs, DISs, draft technical reports (DTRs), DADs, and DAMs in technical committee order. Each entry includes the following information:

- Target Date. When the document is expected to be published as an International Standard.

- Edition. A blank signifies first edition; second and subsequent editions are marked by the appropriate numbers.
- Title. In English and French.
- Stage Number. These range from 2.1 for the first draft proposal to 6.3 for the revised text of DIS.

This same information for OSI (and related) standards is summarized twice a year by OSI layer in the Association for Computing Machinery Special Interest Group on Data Communication (ACM SIGCOMM) Journal *Computer Communication Review* (January and July issues).

The *ISO Catalogue* lists ISO standards by fields and groups. An index is used to locate the relevant field, group, and page number of subjects. Entries give the ISO standard number, year of publication, title, edition, number of pages, price code, and TC that produced the standard.

The *ISO Technical Programme, Catalogue*, and ISO standards and drafts are available in the United States from Omnicom, Inc., 115 Park St. SE, Vienna, VA 22180-4607, 1-800-OMNICOM. ISO standards are also available from NTIS, 5285 Port Royal Rd., Springfield, VA 22161, (703) 487-4650.

CCITT Recommendations are available in the United States from Omnicom, Inc., 115 Park St. SE, Vienna, VA 22180-4607, 1-800-OMNICOM.

NATO STANAGs are listed in *NATO Standardization Agreements and Allied Publications*, AAP-4(1990), which is available (as are the STANAGs) from the NATO Subregistry at the Pentagon, Room 3A948, Washington, DC 20310, (703) 697-6395.

2.3.4.2 ANSI

The *X3 - Projects Manual*, Information Processing Systems Accredited Standards Committee, X3/SD-4, April 1991, lists status of X3 standards projects by Project Number within X3 Subcommittees. Specific information provided includes X3 Project Number and Type, Standard Number, Standard Title, ISO Project Designation, ISO Document Number, and the Estimated Completion Date. To find more current information, the user will need to consult another publication, *Membership and Officers*, X3/SD-6, April 1990, which lists the Chairpersons (including addresses and telephone numbers) of the ASC X3 Subcommittees. These publications are available from the CBEMA, the X3 Secretariat, 311 First St. NW, Suite 500, Washington, DC 20001-2178, (202) 626-5740.

The *Catalog of American National Standards* lists American National Standards alphabetically by subject. The designations of the standards (standards numbers, i.e., ANSI X3.147-1988) serve as locators to the standards listed. Each standards entry gives the designation, year of edition, full title, and selling price.

ANSI standards and some drafts are available from the ANSI Sales Department, 1430 Broadway, New York, NY 10018, (212) 642-4900. The Sales Department also accepts FAX orders at (212) 302-1286.

2.3.4.3 IEEE Computer Society

The IEEE Computer Society's *Standards Status Report*, lists IEEE standards and projects together by IEEE number. Each entry includes the Standard Number (for example, IEEE 1149 or IEEE P1175), Standard Title, Chair or Contact, Short Description of the Standard, and Status Information. Another listing follows, also by IEEE Standard Number, that gives additional status information, including the date it became a standard, a short title, the sponsor, the name of the Chair, the date that the Project Authorization Request (PAR) was approved, and its current status. The names, addresses, and phone numbers of the Chairs and Contacts are listed alphabetically later in the document, if the user wants to contact them.

Published IEEE Computer Society Standards are available from IEEE Standards Sales, 445 Hoes Lanes, P.O. Box 1331, Piscataway, NJ 08855-1331, 1-800-678-IEEE. Draft standards are available from the Assistant Director of Standards, IEEE Computer Society, 1730 Massachusetts Ave. NW, Washington, DC 20036-1903, (202) 371-0101.

2.3.4.4 NIST

Information on standardization activities in the area of computers and information technology is available from the NCSL, Building 225, Room B151, NIST, Gaithersburg, MD 20899, (301) 975-2816.

The Federal Information Processing Standards Publications (FIPS PUBS) Index, NIST Publications List 58 lists the FIPS both by subject category and by number. It gives the FIPS number, subject category, title, date, and number of change notices.

The FIPS Index and the FIPS are available from the National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161, (703) 487-4650.

2.3.4.5 DoD

DoD standardization activities are organized by subject area and coordinated by the Defense Quality Standardization Office (DQSO), 2 Skyline Place, Room 1403, 5203 Leesburg Pike, Falls Church, VA 22041-3466, (703) 756-2343. The areas relevant to the standards in this paper and the respective controlling organizations include the following:

- Data Communications. DISA, Director C3A-SM, Suite 210, 11440 Isaac Newton Square, Reston, VA 22090-5006, (703) 487-8015.
- Information Processing Standards for Computers. HQ USAF/SCXS, Pentagon, Washington, DC 20330-5190, (703) 695-9936.
- Long Haul Communications Area. DISA, Director C3A-SM, Suite 210, 11440 Isaac Newton Square, Reston, VA 22090-5006 (703) 487-8015.
- Tactical Communications Systems Technical Standards Area. Commander, U.S. Army Communications-Electronics Command, ATTN: AMSEL-ED-TO, Fort Monmouth, NJ 07703, (201) 532-5851.

Each area produces an annual standardization document program plan that gives the status of standardization activities. Individual area offices can be contacted for these plans as well as other information regarding emerging standards.

Once a DoD-STD or MIL-STD is issued, it appears in the *DoD Index of Specification and Standards (DoDISS)*, which is available in microfiche or hard copy from either the Navy Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120-5099, (215) 697-3321, or the Government Printing Office Superintendent of Documents, North Capitol and H Sts. NW, Washington, DC 20402, (202) 783-3238. In addition to DoD and Military standards, the DoDISS lists unclassified Federal, Military, and Departmental specifications and related standardization documents, and those industry standards that have been adopted for DoD use. DoDISS contains three listings: (1) Alphabetic Listing, (2) Numerical Listing, and (3) Federal Supply Class (FSC) Listing. DoDISS is published annually in July with bi-monthly supplements.

DoD-STDs and MIL-STDs are available from either the Navy Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120-5099, (215) 697-3321, or the National Standards Association, Inc. (NSA), 1200 Quince Orchard Blvd., Gaithersburg, MD 20878, 1-800-638-8094. Draft standards are available from the DoD standardization areas cited previously.

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3. OVERVIEW OF THE STANDARDS FOR CCISs

3.1 Introduction

One of the underlying principles for WAM is that specifying standards is essential to achieving interoperability. However, specifying standards will not alone guarantee interoperability. Indeed, every standard has a number of system and design parameters or interoperability parameters whose values may need to be fixed in the design phase of implementation. To ensure interoperability, each of these interoperability parameters must also be specified and controlled. Some interoperability parameters are very general and may be used to specify a class of options or mode of operation. Other interoperability parameters may be very detailed, such as restrictions on timing, format size, or bandwidth.

Because each standard is a reflection of the degree to which agreement can be reached in a service area, many important attributes (i.e., interoperability parameters) are often left unspecified or unaddressed. As agreements are reached over time, the standards will improve by addressing more functionality and harmonizing conflicting approaches. In cases where standards identify extensions and other types of options, great care must be taken in standards specification and interoperability parameter control to ensure that whenever an extension or option is permitted, every implementation of the related service also supports this extension or option. This principle is especially important in achieving not only interoperability but also portability of applications from one environment or implementation to another, such as is needed when operating systems, data management systems, interface packages, and hardware are upgraded.

An open system has been defined in IEEE P1003.0 as follows:

> Open System. A system that implements sufficient open specifications for interfaces, services, and supporting formats to enable properly engineered applications software: (1) to be ported across a wide range of systems (with minimal change), (2) to interoperate with other applications on local and remote systems, and (3) to interact with users in a style which facilitates user portability.

There are three major classes of standards applicable to open systems:

- Standards for higher level applications and data representation
- Standards and profiles for OSI
- Standards for bearer circuits and other elements of the external environment.

The classes are shown in Figure 4. Interoperability parameters need to be drawn from all three classes of standards, both from the minimum requirements and from the options within the standards. As will be shown in subsequent chapters, the network services require standards in the lower two classes, whereas the other groups of services (i.e., data exchange, data management, operating systems, programming, user interfaces, and security and OSI management) are addressed primarily by standards for higher level applications and data representation. The application or highest layer of the OSI standards has standards not only for the communication services but also for other groups of services.

3.2 Relationship of CCIS Services to OSI Layers

The first step of the analysis is the classification of the group of CCIS services in terms of the OSI Reference Model developed by ISO. In this model, the functions required for interoperation between data processing systems are divided into seven layers (Figure 5). Layers 1-4 are called the lower layers and are primarily concerned with control of the data transmitted between data processing systems. The Physical Layer (Layer 1) controls data transmission over physical media (e.g., wire). The Data Link Layer (Layer 2) augments the Physical Layer function by providing transmission error control along segments of the transmission network. The Network Layer (Layer 3) controls the data transmission route. The Transport Layer (Layer 4) provides protocols for moving data between end systems on the network.

Layers 5-7 are called the upper layers and are concerned with the interface between end systems. The Session Layer (Layer 5) establishes a logical connection between communicating end systems. The Presentation Layer (Layer 6) ensures that data from the network are presented to the user in an intelligible form. The Application Layer (Layer 7) provides services to the application programs that may request support from other systems on the network in order to complete their user-dictated tasks.

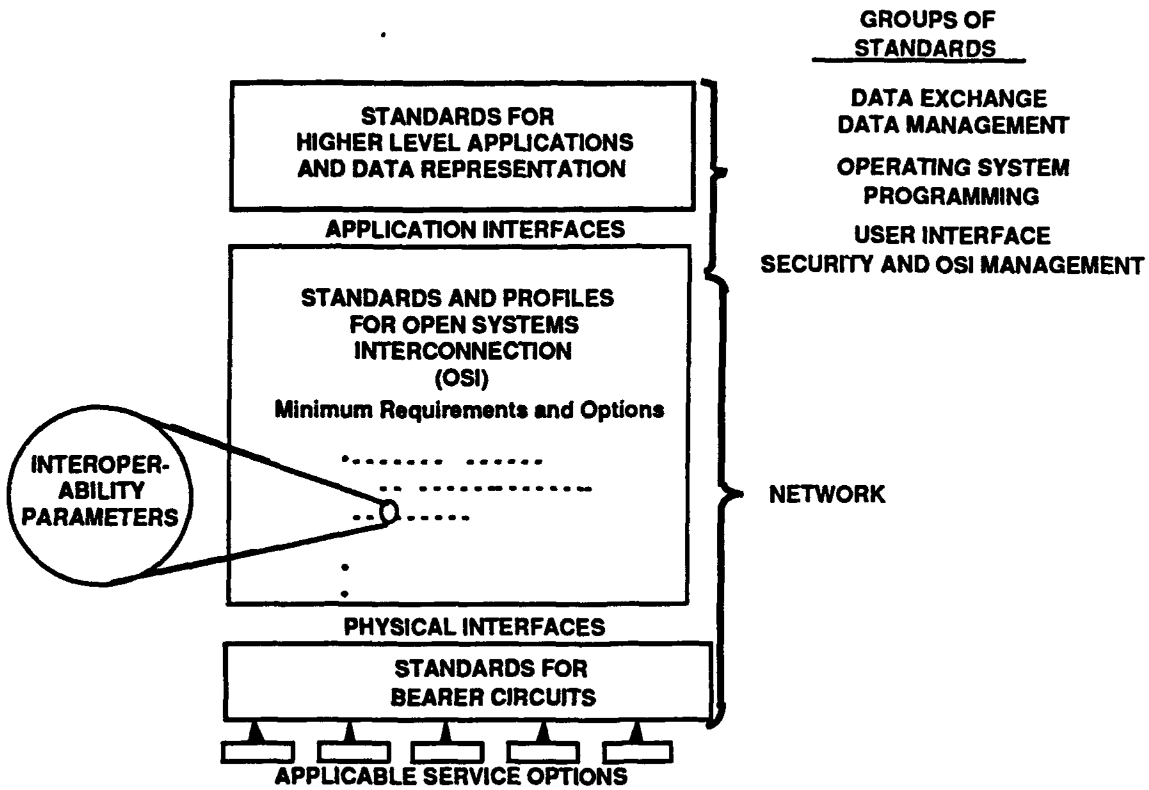

Figure 4. Classes of Standards and Their Relation to WAM Groups of Standards

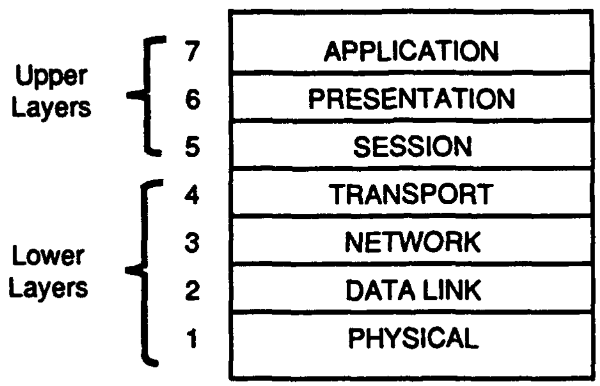

Figure 5. The Seven-Layer Model for Open Systems Interconnection

3.2.1 Basic Options in OSI Standards

Options for international standards that support the OSI model are often designated by grouping the OSI layers into two classes: application options and transport options (Figure 6). Using the definitions of [NATO 1989], the combined Layers 5-7 offer application options, while Layers 1-4 offer transport options. A separate category of relay options that provides interfaces between subnetworks will also be considered. Relay options normally are provided by Layers 1-3 (Figure 7). Examples of these options are illustrated in Appendix B.

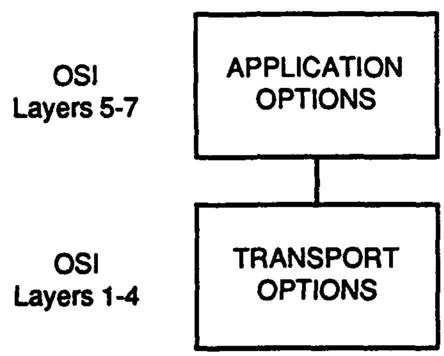

Figure 6. Composition of an OSI System

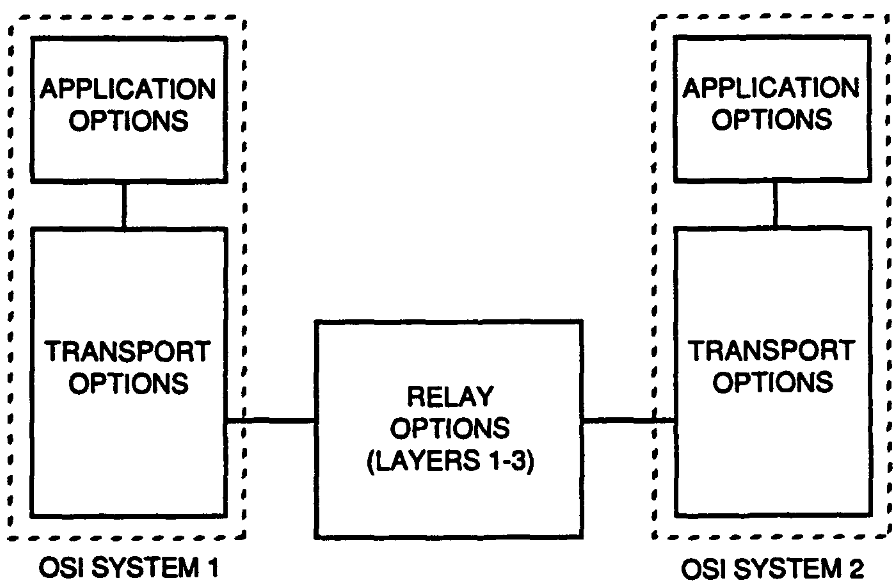

Figure 7. The Role of a Relay

The major application; transport, and relay options in OSI being developed by ISO, IEC, and CCITT are listed in Table 2. The transport and relay options are addressed in Chapter 6 on the network services.

3.2.2 Connection-Oriented and Connectionless-Oriented Transmission Modes

One of the important issues that must be considered when reviewing OSI standards is the choice between connection-oriented (CO) services (also called "virtual circuit" services) and connectionless-oriented (CL) services (also called "datagram" services). Each of the seven OSI layers, except the Physical Layer, may be CO or CL. (The Physical Layer has no connection orientation.) The OSI Reference Model recommends that the upper four layers be either all CO or all CL. The following paragraphs, based on [Purton 1987; Stallings 1985; Stallings 1987a; and NATO 1987], address some prominent distinctions between these two classes of services.

The basic difference between CO and CL service is that CO service requires that an explicit relationship be established between the interacting peer entities before any further activity can take place, while in CL service no such explicit relationship occurs. A connection preserves the state of peer-to-peer communications from one data transfer to the next, storing and distributing information regarding the connection within the service provider, while the CL transmission does not. In CO service the relationship may be real—such as a dedicated circuit—or virtual, such as a particular path from node to node between peer entities in a CO packet-switched service. In the latter case the path would be agreed upon before data transfer begins and would remain unchanged during the transfer. A heuristic example of CO service is any national public telephone service; the regular delivery postal service is a heuristic example of a CL service.

CO service has three phases: connection establishment (set up), data transfer, and connection release (call termination). The route of each data packet is determined by the state of the network during the call set up and remains static for the duration of the connection. Since the state information is maintained for each established connection and the route of data packets is static, the data units are freed from the requirement to carry the full address of the required destination. The CO explicit relationship is established during the negotiation portion of the set-up phase and before the transfer phase. CO service provides for negotiation of the form of transmitted data and may maintain sequence and

Table 2. Application, Transport, and Relay Options Offered by OSI Standards

BASIC APPLICATION OPTIONS

Primary Services:
- Message Handling:
  - Message Handling Service (MHS) [CCITT]
  - Message-Oriented Text Interchange System (MOTIS) [ISO]
- File Transfer Access and Management (FTAM)
- Telematic Services (Teletex, Telefax, Textfax)
- Virtual Terminal (VT)
- Job Transfer and Manipulation (JTM)

Other Services:
- Directory
- Transaction Processing (TP)
- Open Distributed Processing (ODP)
- Remote Data Access (RDA)
- OSI Management
- Application Service Elements (ACSE, RTSE, ROSE, CCR)
- Information Resource Dictionary System (IRDS)
- Office Document Architecture (ODA)
- Computer Graphics Metafile (CGM) and Computer Graphics Interface (CGI)

Transmission Mode:
- Connection Oriented (CO)
- Connectionless (CL)

BASIC TRANSPORT OPTIONS

Subnetwork Types:
- Circuit Switched Data Network (CSDN)
- Packet Switched Data Network (PSDN)
- Dedicated Line (Point-to-Point Subnetwork)
- Switched Telephone Network (STN)
- Integrated Services Digital Network (ISDN)
- Local Area Network (LAN)

Transmission Modes:
- Connection Oriented
- Connectionless

Transmission Media Interfaces:
- Wire
- Radio
- Fiber Optic Cable
- Microwave
- Infrared

BASIC RELAY OPTIONS
- LAN to LAN
- LAN to Wide Area Network (WAN)
- WAN to WAN
- LAN to WAN to LAN

flow control. Error handling may also be supported. The overhead invested in setting up and maintaining a CO connection pays off when the data transfer phase is relatively long. The CCITT Recommendation X.25 for interfacing to a packet switching wide area network (WAN) is an example of a CO protocol.

In contrast, CL service has only one phase—namely, data transfer. The form of the data transferred must be pre-arranged between peer entities. Sequencing, flow control, and error handling are not supported by the CL service, but are instead the responsibility of the interacting peer entities. Sometimes referred to as a "datagram" service, CL service requires each data unit to be self-contained; there is no relationship between individual data unit transfers.

While the service mode at each of the six highest OSI layers may be CO or CL, crossover between the two types of service usually occurs only at the Network Layer (Layer 3). In these cases, the connection orientation of the Application Layer (Layer 7) agrees with the connection orientation of Layers 4, 5, and 6; further, the connection orientation of Layers 2 and 3 also agrees, but this orientation may differ from that of the higher layers. The rationale for maintaining the service mode (CL or CO) throughout Layers 4-7 is based on the recommendation of the ISO Reference Model for simplifying *system and protocol complexity*, specifically that the features at one layer should not be negated by the unavailability of similar services at another layer. The goal of the OSI Reference Model is to limit the amount of *a priori* information exchanged between end systems regarding services used to communicate, which is best met by limiting the mixing of service modes. The following ISO/IEC standards for the four cases of connection orientation of the transport and network services are:

- ISO 8602 for CL transport and CL network
- ISO 8602 for CL transport and CO network
- ISO 8073 for CO transport and CO network
- ISO 8073 DAD 2 for CO transport and CL network.

The many resulting combinations of service are useful in different circumstances. CL service may be appropriate for military applications that require robust networks capable of continuing data transfer even as some nodes are taken out of service, especially for the lower layers (network and data link). [Purton 1987 and Stallings 1987a] give some additional examples of cases for which CL service is appropriate, even for the upper layers. Included are inward data collection from the sampling of data sources, broadcast messages,

some distributed transactions, some real-time transmission applications, and cases in which one or more communicating peers are mobile. In general, CO service is beneficial when long-lived connections with extensive data transfer are anticipated. FTAM is an example of an application that would likely benefit from a CO connection.

The cases in which Layers 2 through 7 are all either CO or CL are more straightforward than cases with upper and lower layers of different orientation. If CL upper layers operate over CO lower layers, the full functionality of the lower layers is not employed; the application in this case does not enjoy the amenities of CO service.

The OSI standards supporting CO service were the first to be developed and are nearly complete. Until recently, standards supporting the lower layer CL service were more advanced than those supporting upper layer CL services. CL protocols for the Transport Layer (ISO 8602), Session Layer (ISO 9548), and Presentation Layer (ISO 9576) are complete.

Choice of connection orientation affects the structure of the Network Layer and to some degree the performance of services in the Network and Transport Layers. The Network Layer is divided into three sublayers (ISO 8648, *Internal Organization of the Network Layer*). From top to bottom they are the Subnetwork Independent Convergence Protocol (SICP), the Subnetwork Dependent Convergence Protocol (SDCP), and the Subnetwork Access Protocol (SAP). This structure is preferred by many European countries. In a CL network, the Network Layer is divided into two sublayers: Internetwork Protocol (IP) and Subnetwork Specific Protocol (SSP), where the IP focuses on unreliable internetwork transfer of information while the SSP focuses on the reliable transfer of individual data units across the supporting networks. The CL approach is favored by the United States [compare the OSI profiles recommended by the United Kingdom and the United States given in Section 6.4.3, noting that ISO Class 4 Transport Protocol (TP4, discussed below) provides services for CL networks]. In the CL model, end-to-end responsibilities are placed in the network sublayers, whereas in the CO approach the end-to-end requirements are placed in the Transport Layer. One drawback of using TP4 over a CO network is the size and complexity of the implementing code. For this and other reasons, many implementors of CO stacks do not support TP4. Section 6 of [NATO 1987] provides an analysis of the impact of the choice of CL or CO mode on the interconnection of heterogeneous military networks.

As in the Network Layer, there are significant differences in the protocols for the Transport Layer in connectionless and connection-oriented modes. The CL transport

protocol (TP) makes use of only a subset of the CO network services, while the CO TP makes use of all the CO network services. The CL transport service is not expected to provide ordered delivery, flow control, or error control. Hence, the CL TP is very simple and requires only a single type of transport protocol data unit (TPDU). Ten types of TPDUs are used to provide CO transport services. There are five classes of the CO TP, of which only Class 4 can make use of a CL network service [Stallings 1987]:

- Class 0. Simple class, oriented for Teletex (upgrade to CCITT T.70). Connection flow control is based on network flow control, and connection release is based on release of the network connection
- Class 1. Basic error recovery class, designed to run on a CCITT X.25 network and provide minimal error recovery for network-signalled errors. TPDUs are numbered so that they can be resequenced
- Class 2. Multiplexing class, an enhancement of Class 0 that still assumes a highly reliable network service. Has the ability to multiplex multiple transport connections onto a single network connection
- Class 3. Error recovery and multiplexing class. Provides the union of the capabilities of Class 1 and Class 2
- Class 4. Error detection and recovery class. Assumes that the underlying network service is unreliable, in particular that the TPDUs may be lost or arrive out of sequence. Provides for TPDU retransmission, duplicate detection, flow control, connection establishment and termination, and crash recovery.

3.3 Military Requirements for OSI

This section summarizes the requirements associated with incorporating military enhancements into OSI standards. Within NATO, this work has been assigned to TSGCE SG9. General information on NATO and international standards bodies concerned with OSI standards is provided in Appendix F. Appendix K describes military initiatives for use of open systems.

Beginning in February 1983, a number of military requirements have been identified in NATO that are not adequately covered by existing OSI standards. Eight military features were identified in the NATO Interoperability Management Plan (NIMP) [ADSIA 1988], and TSGCE SG9 has recommended that the OSI Reference Model (STANAG 4250) be extended to provide support for these features:

- Multihomed, mobile host systems
- Multi-endpoint connection

- Internetworking .
- Network/system management functions
- Security
- Robustness and quality of service
- Precedence and preemption
- Real-time and tactical communications.

Table 3 gives the description of the eight military features as provided in *Use of OSI Standards in NATO—Strategic and Technical Issues,* March 1988 [UK 1988].

Table 3. Eight Military Features for Enhancing OSI in NATO

(1)	Multihomed and mobile host systems. Multihoming is a mechanism for attaching an end system to two or more network access points without the need for a system setting up a call to it to be aware of the extra connectivity. In addition to enhancing survivability, this facility may be extended to support "mobile hosts" such as aircraft and ships.
(2)	Multi-endpoint connections [multi-addressing; multipeer data transmission (MPDT)].[5] In order to transmit data to a number of recipients, it is usually necessary to establish several connections and send separate copies of the data across each connection in turn. More efficient use is made of the communications resources if the sender has to transmit only one copy of the data. The network then takes care of routing, control, and distribution of the data.
(3)	Internetworking. Mechanisms are required to facilitate the interconnection of various NATO systems at the boundary point between subnetworks.
(4)	Network or system management functions. Management functions are required that may be of greater sophistication than those considered satisfactory for civilian networks. Management of broken networks in which layers of protocols are inoperable and fast responses to changes in network topology are essential to maintain important connections.
(5)	Security. Protection measures are required to prevent unauthorized access to information, preserve the integrity of data, and to mitigate against denial of service. [Note: Security includes access control, authentication, integrity, and confidentiality.]
(6)	Robustness (resilience) and quality of service. The range of quality of service parameters required for military systems exceeds that currently permitted within commercial OSI networks. In particular, in order to maximize the survivability of a network, the NATO aim is to maintain an adequate quality of service to the users (or at least to users operating above a given priority level) in the face of a severely damaged or partitioned network.
(7)	Precedence and preemption. In order to minimize congestion, particularly in a damaged network where resources are at a premium, it is desirable to be able to allocate resources on the basis of priority levels assigned to the connections being routed through the congested area. A facility is therefore required to associate a priority level with a connection when it is established.
(8)	Real-time and tactical communications. Certain applications are prepared to sacrifice such aspects of quality of service as sequencing and guaranteed delivery to achieve the minimum possible transit delay.

Source: *[UK 1988].*

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5 As indicated in Section 6.2.1, work in ISO on MPDT has been suspended in SC21/WG1. The completed work is planned to be released as a Technical Report. Canada is serving as the point of contact within SG/9 for maintaining interest in MPDT in ISO. Canada has introduced a draft proposal in ISO for Multi-Party Communications that would address MPDT.

A top-level view of how the eight military features identified above could potentially affect the layers of the OSI Reference Model is provided in Table 4. The entries in the table are based on the 1990 editions of the draft OSI STANAGs (see Appendixes J and K). This table is only an example of how the military features could potentially affect the layers of the OSI Reference Model; other sources would undoubtedly complete the table differently. The United States Data Communications Protocol Standards (DCPS) Technical Management Panel (DTMP) (formerly the PSTP) has reduced the number of military features to five, indicating, for example, that internetworking is no longer a required military feature because commercial international standards have developed significantly since the military features were first identified. TSGCE Subgroup 9 is considering reducing the number to three: Security, Quality of Service, and Network Management [PSSG 1991, 7].

Table 4. Impact of Military Features on Layers of OSI Reference Model

Military Feature	OSI Layer						
	1	2	3	4	5	6	7
1. Multihomed, Mobile Host Systems			X				X
2. Multi-Endpoint Connections			X			TBD	X
3. Internetworking			TBD				
4. Network or System Management Functions	TBD	TBD	TBD				X
5. Security	X		X	TBD		TBD	X
6. Robustness and Quality of Service	TBD		X	TBD		TBD	TBD
7. Precedence and Preemption			X	TBD			X
8. Real-Time and Tactical Communications			X	X		TBD	TBD

Key: X = A deficiency has been identified in the applicable draft STANAG.

Sources: *[UK 1988;* France 1989; NOSA 1988; and recently released draft OSI STANAGs (through July 1990)].

With respect to the eighth military feature, "Real-time and Tactical Communication," MITRE developed a proof-of-concept prototype system to test the applicability of GOSIP protocols in the tactical environment and concluded that the full OSI protocol stack could be used for tactical messaging if the use of OSI Congestion Avoidance is required and the number of Message Transfer Agents (MTAs) that must be

traversed is minimized. In addition, the architectures of the implementations must focus on efficient queue handling and connection handling [Messing et al. 1990].

3.4 Applications Portability

3.4.1 Requirements for Applications Portability

Portability is a software attribute representing the ease and cost effectiveness with which that software and data can be used on heterogeneous hardware/software platforms. Three key aspects of portability are the operating system, database access, and applications software. Hardware environment changes that require change of the operating system are in many cases significant to portability. This aspect of application portability is addressed by enforcing a standard (POSIX) for an operating system *interface*. The interoperability aspects of information exchange mean that CCISs need to have a consistent way to record meanings and relationships of data, and to distribute and replicate the data and changes to the data. This leads to the need to standardize the data models (schema) for databases and the services for accessing those databases. SQL is an example of a standard for services to databases conforming to a relational data model. Additional standards may need to be developed for other data models. Standards for applications software take the form of programming language standards, together with standard methods for using the programming language.

Following the guidelines and standards will improve the prospects, but not guarantee, application portability. Many aspects of implementations of POSIX, SQL, and Ada environments are inherently hardware dependent. Further, the standards do not provide all the needed services. Use of nonstandard options available in the implementations of operating systems, SQL, and programming languages can greatly restrict portability.

3.4.2 Organizations Promoting Applications Portability

3.4.2.1 ISO

In April 1988, JTC1 of the ISO/IEC began a formal Joint Technical Study Group (TSG-1) for Applications Portability (JTAP). Managed directly under the JTC1, and not any of the subcommittees, the JTAP study addressed five areas: (1) concepts and definitions related to applications portability, (2) user requirements, (3) portability issues, (4) internationalization (to investigate the interface requirements of users with different

cultural backgrounds), and (5) a framework for interfaces for applications portability (IAP). The final report [JTAP 1991] contains eleven recommendations. It does not contain an explicit list of application portability standards as mentioned in the original mandate because such a list would comprise almost all of the JTC1 projects and standards. It is anticipated that JTAP will terminate by early October 1991. The recommendations of the JTAP report are that JTC1 should do the following:

1. Instruct its standards groups to use the methods and concepts described in the report.
2. Establish channels of communication with groups outside JTC1 in order to assist them in developing, recording, and using application environment profiles.
3. Use application environment profiles to identify standards work needed.
4. Establish procedures for managing application environment profiles, taking both user requirements and TR10000-1[6] into account.
5. Establish procedures for the coordination of the work on base standards and application environment profiles that may lead to the development of new standards.
6. Initiate work to develop a taxonomy for application portability.
7. Instruct all of its standards groups to implement the portability considerations of Annex A [to the JTAP report] ("Necessary Portability Considerations for all JTC1 Standards Development").
8. Publicize activities in relation to the development of standards relevant to application portability in order to increase user awareness and participation, and promote the early use of standards.
9. Solicit user needs and priorities when initiating and guiding work relevant to application portability.
10. Should review its mechanisms for coping with subjects that span multiple subcommittees such as application portability, security, and internationalization.
11. Should establish means (e.g., Special Group) for:
    - Interacting with user groups

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[6] TR10000 is an ISO technical report by the Special Group on Functional Standardization (SGFS) detailing the framework and taxonomy for International Standardized Profiles (ISPs). See Section 6.4.2.

- Recording application environment profiles
- Developing a taxonomy for application portability.

As a result of the JTAP work, SC22 has initiated Working Group 20 on Internationalization. The Group will take the POSIX work as input to address the complex technical problem of porting applications across other languages and cultures.

ISO has recognized that standardization is needed for information processing that goes beyond data communications services and protocols. As will be shown in the sections that follow, there are major efforts under way in the areas of standard interfaces to operating systems, databases, graphics, user input and display devices, and programming languages. In addition, open systems standards are being developed for document interchange and distributed processing.

SC21 has identified [SC21 N 3134 1988] the need to provide standardization in the following areas related to CCIS interoperability:

- Information exchange
- Internetworking of systems
- Specification of functions needed in systems built for specific purposes
- Portability of applications across system hardware and software
- Definition of common interfaces to system services
- Security of systems
- Reliability of systems
- Human-computer (man-machine) interfaces
- Definition of common concepts
- Safety and legal requirements.

SC21 specifically plans to address standardization for database management systems and single and distributed processing environments, in addition to open systems interconnection.

3.4.2.2 National Institute of Standards and Technology (NIST)

NIST has been working with the IEEE and other U.S. organizations to identify environments for open systems that can be specified with existing OSI and other opens systems standards. The NIST recommendations are contained in the APP, discussed in Section 3.4.3.3. NIST is promoting in the United States the concept of an Open System

Environment (OSE), which "integrates POSIX with U.S. GOSIP and provides the additional functionality required to accommodate a broad range of requirements. . . An OSE extends the OSI concept to the broader problems of applications portability and interoperability" [NIST 1990].

The OSE concept is relatively new and has not matured to the stage where it is possible to completely define an OSE in terms of international standards. In the absence of appropriate international standards, organizations have used suites of specifications called Application Environment Profiles (AEPs) to support OSE functions. The AEPs reflect required functions, the organization's view of the viability of a particular specification for migration to the international standard when that standard is established, and availability of commercial off-the-shelf products that conform to the specifications. The NIST APP is an AEP developed for use by U.S. federal agencies.

3.4.2.3 X/Open

X/Open is a non-profit consortium developing extensions to UNIX SVID operating system standards to support a distributed transaction processing environment that meets OSI standards. X/Open is developing a Common Applications Environment (CAE) to promote applications software portability. This is planned to be achieved by adopting and adapting existing industry and *de facto* standards, rather than by creating a new standard.

The X/Open System V Specification (XVS) is the initial recommended standard for the operating system. Future goals for the CAE are alignment with POSIX P1003.1 (with a large number of extensions) and ANSI X3J11 C together with interfaces for Indexed Sequential Access Method (ISAM) and an embedded standard relational database language (SQL). The X/Open version of ISAM is based on a major (implementation nonspecific) subset of C-ISAM Version 2.10 (January 1985) from the Informix Corporation. The initial X/Open version of SQL is not fully compliant with ANSI X3.135-1986 [X/OPEN 1987; X/OPEN 1988; Lambert 1987]. Standards recommended for the CAE are discussed in Section 3.4.3.4.

3.4.2.4 Open Software Foundation (OSF)

The Open Software Foundation(OSF) is an international consortium formed in May 1988 to promote applications portability. OSF is identifying technologies and products to be included in its Distributed Computing Environment (DCE). In December 1990, OSF issued the first release of its OSF/1 operating system. OSF has integrated a number of

existing advanced technologies into its vendor-neutral operating systems. As noted in Section 7.2.2, OSF/1 includes significant portions of IBM's AIX 3.1 operating system and the Mach kernel technology from Carnegie Mellon University. OSF expects to release subsequent versions of OSF/1 every 12 to 18 months [OSN 1990]. Other standards recommended for OSF are identified in Section 3.4.3.5.

3.4.3 Standards for Applications Portability

This section discusses the standards recommended as profiles for applications portability. Each of the major recommendations is based on POSIX. The areas addressed are Interfaces for Applications Portability, NIST APP, United Kingdom's (U.K.) Ministry of Defense (MoD) Model, X/Open CAE, OSF, the Technical and Office Protocol (TOP), Multivendor Integration Architecture (MIA), and EWOS Profiles for Open System Environment.

3.4.3.1 Interfaces for Applications Portability (IAP)

JTAP [JTAP 1990] examined the interfaces that need to be standardized in order to facilitate portability of applications. It concluded that there are three types of portability: programs, data, and people. Thus, standards relevant to IAP must address the following:

- Source code portability
- Data portability
- User interface
- Documentation portability
- Operating system interfaces
- Communication services
- Database management services
- Software engineering tool interfaces
- Internationalization.

Further, the JTAP study identified the following IAP issues to be addressed in JTC1:

- Standards need to define consistent handling for exceptions encountered by applications during execution.

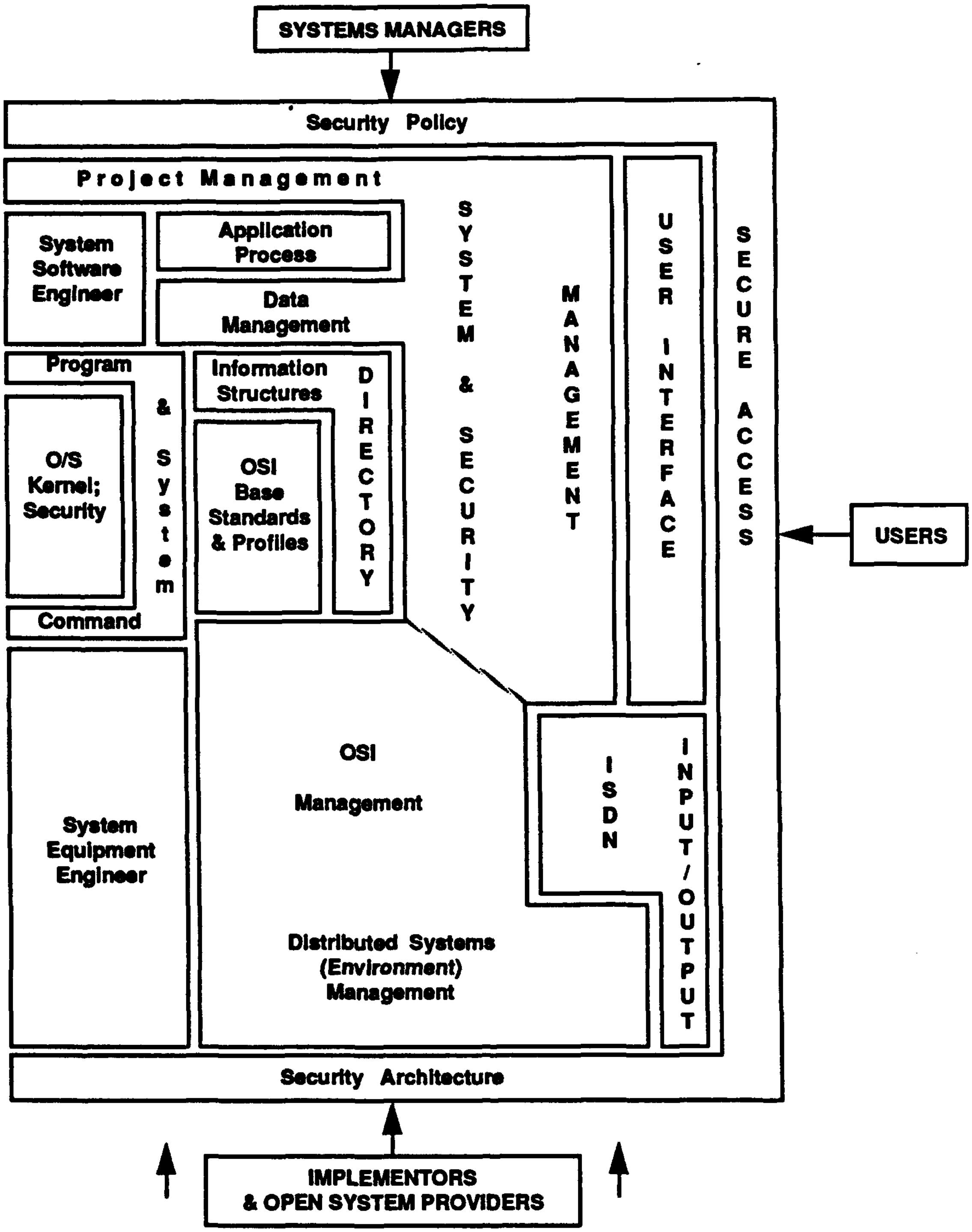
- Standards need to identify ways to enable adaptation of applications by automated means to accommodate options and other environmental variations (e.g., implementation-defined characteristics, option identification).
- Standards for IAP need to take into account external object names, providing methods to minimize the impact of variations of external object names across application platforms. Language standards need to provide corresponding services and capabilities to enable applications to accommodate these variations (e.g., variable length strings, services for acquiring object names from external sources, object name composition/decomposition).
- Qualitative metrics for application portability may be useful.

IAPs can be language independent, operating system independent, or both. Proposed work in SC21 will be for IAPs that are both language and operating system independent. Language-specific constructs could be developed in SC22, as the mapping of abstract data types to language-specific constructs is primarily the work of defining language bindings.

Specification of an IAP would include definition of data types of the interfaces and may include rules for describing behavior and sequencing of functions within an interface (e.g., blocking or non-blocking procedure calls) and levels of enforcement of these rules. A model of IAPs is needed and should be related to or possibly included in the models for Extended ALS (Application Layer Structure) (XALS) and ODP. It was proposed that the IAP model, as well as the XALS and ODP models, should include a means to extend the interface to include user- or application-specific extensions or abstractions. For example, it should be possible to invoke a procedure to store application data type within the X.500 Directory Service without changing the interface definition [SC21 N 4523 1990].

3.4.3.2 Example Model for the Open Systems Environment

Figure 8 provides an example of a model for an open systems environment developed by the U.K.'s MoD [MoD 1989]. It includes users, developers, managers, and providers. It also explicitly includes security and OSI system and project management.



Source: [MOD 1987]
OS: Operating System
ISDN: Integrated Services Digital Network

Figure 8. A Model for the Open Systems Environment

3.4.3.3 NIST Applications Portability Profile

This section discusses the APP developed by the NIST. The NIST approach to applications portability is based on recognition of the for an architectural approach that provides interfaces for functionality to accommodate a broad range of applications requirements. The functional components of the architecture are viewed as a "tool box" of standard elements that can be used to develop and maintain portable applications. These tools are based on an open systems concept and are required to be developed as an integrated collection of non-proprietary standards. The NIST OSE embraces three concepts:

- Extensibility. Based on an architectural framework that allows an extensible collection of interfaces, services, protocols, and supporting formats to be defined
- Non-proprietary. Interfaces, services, protocols, and supporting formats defined in non-proprietary specifications
- Consensus based. Evolution is controlled by a consensus-based process for definition and specification of interfaces, services, protocols, and supporting formats.

Moreover, it stresses the following:

- Portability. The ability to use application software and data on heterogeneous hardware and software platforms
- Interoperability. The ability to have application and software operating on heterogeneous hardware and software platforms cooperate in performing some user function
- Scalability. The ability to use the same applications software on many different classes of hardware and software platforms, from personal computers to supercomputers.

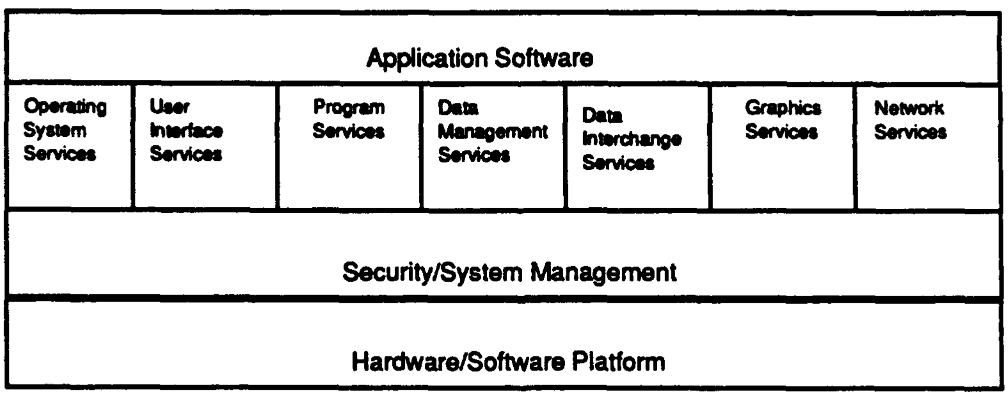
A full complement of standards should be available under the APP by 1995 [APP 1991]. Version 1 of the *Application Portability Profile (APP): The U. S. Government's Open System Environment Profile OSE/1* (NIST Special Publication 500-187) was published in May 1991. It recommends 26 standards and specifications, provides guidance in areas where standards do not exist for seven service areas, and makes strategic evaluations with respect to those standards. The three strategic classifications are as follows:

- Strategic now. Users reasonably safe in making substantial investment and long-term plans in mission-critical systems and infrastructure
- Strategic in the future. Specifications subject to change but appear to be headed for standardization; some risks but consensus process minimizes them
- Nonstrategic. Stop-gap recommendations with warning that user investment will be at significant risk; not appropriate for long-term planning.

APP specifications are selected according to the following order of precedence: International Standards, U.S. National Standards (e.g., ANSI, IEEE), U.S. National Standards Committee work in progress, other Federal standards (e.g., DoD standards), and specifications that are publicly available and for which implementations are commercially available from a variety of sources (e.g., X Window System, Version 11) [Fisher 1991].

Figure 9 provides a high-level view of the architectural approach that underlies the APP. The APP comprises six of the seven service areas identified for WAM (see Section 3.5). The differences are that Graphics is a separate service in the NIST APP but considered part of Data Exchange in this paper and Security and OSI Management are not explicitly shown as a service in the NIST APP since they are assumed to be integral to all other services.

OSE SERVICES



Source: [Fisher 1991]

Figure 9. An Example View of the Architecture for the Applications Portability Profile

Table 5 identifies the elements (tools) and the associated interface specifications of the recommended standards [APP 1991] for the APP. The key elements are OSI for data communications; (extended) POSIX for the operating system interface; SQL and IRDS for database management; and X-Windows for the user interface.

Table 5. Standards for the Applications Portability Profile

Function	Element	Reference for Standards
Operating System	Extended POSIX	IEEE P 1003.1+Extensions (FIPS 151)
Data Management	SQL IRDS RDA	ISO 9075 (FIPS 127) ANSI X3.138 (proposed FIPS) ISO 9759
Data Interchange		
Graphic Data Interchange	CGM	FIPS 128
Graphics Services	GKS PHIGS	ISO 7942, ISO 8651, ISO 8805 FIPS153
Product Data Interchange	IGES STEP	NBSIR 86-3359, NBSIR 88-3813 DP 10303
Document Interchange	SGML ODA/ODIF	ISO 8879, ISO 9069, ISO 9070, TR 9573 ISO 8613
Network Services		
Data Communications	OSI	GOSIP (FIPS 146)
Transparent File Access	TFA	IEEE P1003.8/x
Distributed Computing Services	OSF/1	
User Interface	X-Windows	FIPS-158
Programming Services	C Cobol Fortran Ada Pascal PCTE+ SCCS	ANSI X3J11/86-151-Oct 1986, X3.159 ANSI X3.23-1974, 85, FIPS 021-2 ANSI X3.9-1978, FIPS 069-1 FIPS 119 ISO 7185-1983 (FIPS 109) ECMA AT&T

Source: [APP 1991]
GKS: Graphical Kernel System
IGES: Initial Graphics Exchange Specification
ODIF: Office Document Interchange Format
PHIGS: Programmer's Hierarchical Interactive Graphics System
SGML: Standard Generalized Markup Language
STEP: Standard for Exchange of Product Model Data

An extended version of POSIX is recommended for the operating system interface (see Section 7.2.1). SQL (see Section 5.2.2.2) and the Information Resource Dictionary System (IRDS) data dictionary standard [Goldfine et al. 1988] (see Section 5.2.4) are recommended for database management. The distributed data component will be handled

through Remote Database Access (RDA) (see Section 5.2.3). Recommended for data interchange are the following:

- Computer Graphics Metafile (CGM) (see Section 4.2.2.2)
- Initial Graphics Exchange Specification (IGES), used for engineering graphics (see Section 4.2.1)
- Standard for the Exchange or Product Model Date (STEP) (identified in Section 4.2.1)
- Standard Generalized Markup Language (SGML) (see Section 4.1.2)
- Office Document Architecture/Office Document Interchange Format (ODA/ODIF) (see Section 4.1.1)

Graphics Kernel System (GKS) and Programmer's Hierarchical Interactive Graphics System (PHIGS) are recommended for Graphics Services (see Sections 4.2.2.3 and 4.2.2.4).

Standards and options identified in U.S. GOSIP (see Section 6.4.3) are recommended for the open systems data communications, as well as Transparent File Access (TFA). OSF/1 Network Computing Services (NCS) is recommended for distributed computing services. X-Windows is recommended for the user interface, providing a non-proprietary windowing capability. Five standard programming languages are recommended (C, Cobol , Fortran , Ada, and Pascal), but standard bindings to POSIX for some of these languages (all but C) are still being defined [Martin 1990; Hankinson 1988; APP 1990]. In addition, the ECMA's Portable Computer Tools Environment (PCTE) (see Section 8.3.2) and the Source Code Control System (SCCS) from AT&T are being recommended for programming services.

NIST plans to update the *APP Guide* every six months. Some planned APP enhancements include adding more about integrated software engineering environments to the Programming Services area and possibly replacing the Graphics Services area with Multi-Media Services. New APP initiatives that NIST may undertake include the following [Hankinson 1991]:

- Registry of public specifications (for example the consortium specifications from OSF, X/Open, and OPEN88)
- Repository of Open System Frameworks
- Implementors' Workshops, similar to those NIST holds for OSI and ISDN to give APP standards and specifications more rigorous definition.

The IEEE Computer Society's Technical Committee on Operating Systems (TCOS) has formed a number of working groups to progress POSIX and other standards that are required to facilitate applications portability. Table 6 identifies the documents (and working groups known by the same name) being prepared by IEEE on areas other than POSIX for application portability [NIST 1990a]. The scope and status of POSIX standards work are discussed in Section 7.2.1.

Table 6. Applications Portability Standards Being Developed by IEEE for Submission to ISO Through ANSI

P1003.0, *Applications Portability Guide*--addresses the broad applications portability issues, such as: benefits and risks of open system architecture, architectural framework for portability, applications portability concepts, operating systems services, data management and interchange services, data interchange services, graphics services, network services, user interface services, and languages/application development environment services
P1201.1, *Interfaces for User Portability*--defines a formal standard for programming interfaces for the portability of application software that employs Graphical User Interfaces (GUIs) based on the Xt Intrinsics and Xlib programming interfaces defined by the X-Window System
P1201.2, *Drivability*--defines a recommended practice for those elements and characteristics of user interfaces that must be consistent to permit users to easily transfer from one look-and-feel or application to another
P1201.3, *User Interface Management System (UIMS)*--defines a language-independent dialogue applications programming interface to develop applications systems that are independent of user interface concerns and can be more easily ported across a wide range of user interface styles and technologies; would address such features as: separation of presentation-dependent and presentation-independent aspects, and mechanisms for data and control exchange between application and dialogue layers (not yet approved by TCOS)
P1201.4, *Xlib*--submits for direct ballot, without any changes to semantics or syntax, the MIT X Consortium's X-Window System specification X11 (Release 4) of the Xlib functional specifications with integrated C language binding (direct ballot planned for early 1991)
P1224, *X.400 Mail Services Applications Programming Interface (API)*--defines an API to X.400 mail services for gateways ... supports transfer of mail through an X.400 message transfer system Based document is from X.400 API Association and X/Open. Work to be done before the ballot include adding language independence features, adding assertions and other test methods, and reformatting the standard into IEEE/ISO form. (Ballot planned for mid-1991)
P1237, *Remote Call Procedure (RPC) Interface Language*--defines an interface description language and a very limited set of procedure interfaces to allow applications to use an underlying RPC mechanism layered on an OSI stack (balloting planned for mid-1992 and approval early in 1993)
P1238 *OSI Application Program Interfaces*, Part 1: *Common Connection Management and Supporting Functions*--defines an API model for connection-oriented OSI Application Layer services (ballot in early 1992]
P1238.1, *OSI Application Program Interfaces*, Part 2: *File Transfer, Access, and Management (FTAM)*--provides an application program interface to the detailed OSI FTAM services and higher-level user-oriented FTAM-based services (ballot in 1993)

Sources: [NIST 1990a]; Updated from [Martin 1991a]

A review of the interface specifications for the APP shows that there are not yet international standards for many of the elements of the recommended architecture. Some are being considered by ANSI, IEEE, and other standards defining bodies, and others are

U.S. standards. For example, X-Windows is being considered by the X3H3.6 ANSI working group, and has been promulgated as FIPS 158. The C language bindings are being considered by the X3J11 ANSI working group. NIST is developing interim standards for file management and is recommending NFS to IEEE P1003 as the best starting point for these interfaces [Hankinson 1988]. The engineering graphics standard (IGES) is still only available as a NIST publication.

3.4.3.4 X/Open Common Applications Environment (CAE)

This section discusses the CAE developed by the X/Open international consortium and specified in the X/Open Portability Guide [Lambert 1987; X/OPEN 1987; X/OPEN 1987a; X/OPEN 1988; XPG3 1989]. The Portability Guide recommends standards and options within standards to achieve an open environment in which new applications can be ported without modification. Several international consortia have endorsed the X/Open CAE as a basis for developing open environments.

The foundations of the X/Open CAE are the interfaces of the UNIX System V operating system, as defined in the AT&T System V Interface Definition (SVID), and the C language. The X/Open CAE consists of features grouped in five functional areas: operating system, languages, data management, hardware, and networking. The Third Edition of the Portability Guide (XPG3), published in 1989, defined the CAE in seven volumes:

- Volume 1, System V specification commands and utilities
- Volume 2, System V specification interface and headers
- Volume 3, System V specification supplementary definitions
- Volume 4, Programming languages (revised from earlier version; the Cobol definition is aligned with ANSI Cobol 85)
- Volume 5, Data management (revised)
- Volume 6, Window management (completely new)
- Volume 7, Networking surfaces (completely new).

The next phase of the X/Open CAE will complete the convergence with the current POSIX standard (IEEE P1003.1).

The primary feature of the operating system is the X/Open System V Specification (XVS) that defines the applications interfaces to be provided by the underlying operating system. Another feature of the operating system functional area is the X/Open Native

Language System, which is a set of interfaces designed to facilitate the development of applications that can operate in different languages and cultural environments. These two features are defined in the following ways:

- XVS mandates the entire SVID base definition with the exception of the mathematics group.
- XVS has extended the SVID, including extended use of symbolic names to replace numeric constants.
- Some of the SVID kernel extensions are optional in XVS (use of these options could restrict portability).
- The Native Language System is supported by a message catalogue system (messages in the appropriate language are retrieved at run time); a mechanism whereby native language, local custom, and code-set requirements can be identified to applications at run time; enhanced interface definitions of standard C library functions to provide language-dependent character-type classification and special conversions; and a set of standard commands and library functions that will operate correctly with 8-bit characters.

The C language is the primary feature of the language functional area. The X/Open Portability Guide provides guidelines for writing programs designed to be portable and to avoid problems that arise between the AT&T System V C language standard (used for the initial X/Open standards) and the draft standard issued by ANSI X3J11 X/Open has also established definitions for Cobol (based on ANSI X3.23-1974), Fortran (based on Fortran 77, ANSI X3.9-1978), and Pascal (based on ISO 7185-1983 Level 1).

Data management includes Indexed Sequential Access Method (ISAM) interfaces that are defined for creating, managing, and manipulating indexed files, and SQL for access to relational database management systems. The ISAM definition is based on Version 2.10 of C-ISAM by the Informix Corporation. SQL is based on ISO 9075 (ANSI X3.135-1986) but contains extensions and deviations (see Section 5.2.2.2).

Hardware includes media and formats defined for transferring source code in machine-readable form. The features include 40- and 80-track 5 1/4-inch floppy disks, 1/2-inch magnetic tape, and utilities for transferring files. The primary magnetic tape format is 9-track, phase-encoded at 1,600 bits per inch.

Networking is based on ISO standards and interim standards recommended by the Standards Promotion and Applicaticns Group (SPAG). X/OPEN is working to develop definitions in three areas where there are not yet standards:

- Generalized interprocess communications, with detailed definitions for message passing between processes, shared memory, and semaphores
- Distributed file system
- Distributed transaction processing.

XPG3 was offered to the European Committee for Standardization/European Committee for Electrotechnical Standardization (CEN/CENELEC) as a standard in 1989. Balloting on Draft European Standard (prENV) 40002 was unsuccessful [CEN 1989]. XPG3 consists of 12 components (listed with reference to other standards work as applicable):

- X/Open System Interfaces (XSI) Commands and Utilities (DP 9945-2, IEEE P1003.2)
- XSI System Interfaces and Headers (ISO 9945-1; IEEE P1003.1)
- XSI Internationalization
- XSI Curses Interface
- Source Code Transfer
- C Language (DP 9899; ANSI X3.159; SC22/WG14 work)
- Cobol (ISO 1989; SC22/WG4 work)
- ISAM (ANSI X3.23 work)
- SQL (ISO 9075)
- Window Management Library Interface
- Transport Interface (IEEE P1103.8)
- Personal Computer Interworking.

The following summarizes some of the comments provided to CEN and EWOS regarding the adoption of the Portability Guide as a European Standard (ENV) [CEN 1989]:

- XPG3 depends totally on UNIX, which needs an AT&T license, and the AT&T version of C Programming Language which differs from ongoing work in SC22/WG14 (Denmark).
- The X/Open Cobol does not agree with ISO 1989 Cobol; the X/Open recommendations appear to match only one existing product (the MicroFocus compiler). X/Open Cobol excludes some features and specifies some extensions to ISO 1989. There is no real coordination between X/Open recommendations and SC22/WG4 (France).

- The X-Windows standard differs from the one developed at MIT and currently is being used to progress such work in ANSI for possible submission to JTC1 (United Kingdom).

3.4.3.5 Open Software Foundation (OSF) Profiles

The OSF has identified a Level 0 portability profile that is based on the following elements:

- POSIX and the XPG3
- Programming language bindings for ANSI C, Cobol , Pascal, Ada, Basic, and Lisp
- X/Windows
- GKS and PHIGS for graphics
- OSI protocols for networking
- Database Language SQL.

The Level 1 OSF profile standards are still being defined through a request for technology (RFT) process. The base standard for the operating system will be the IBM AIX Version 3 of UNIX. This will be compatible to UNIX System V Releases 2.0 and 3.0 and conformant to POSIX [OSN 1988a]. The GUI will be a combination of the Microsoft OS/2 Presentation Manager, the Hewlett-Packard window manager, and the Digital Equipment Corporation's toolkit.

OSF is planning a develop a DCE that includes such "technologies" as Architectures, Remote Procedure Call, Naming and Directory, Authentication and Authorization services, Time Management services, Distributed File services, and others [OSF 1990].

OSF recently issued an RFT for defining and implementing a distributed management environment (DME). The DME is intended to allow heterogeneous computing systems to be managed in a uniform and efficient manner. It will consist of a framework that supports a consistent management approach as well as management applications, common management services, and management information storage systems. After assessing scope, quality, and completeness of the submissions, OSF plans to announce its final selection in the second half of 1991 [OSN 1991].

3.4.3.6 Technical and Office Protocol (TOP)

The TOP is part of a combined industrial and government effort on the part of users to specify a profile of standard protocols that can be used in commercial applications to provide connectivity and interoperability. TOP is associated with another effort, Manufacturing Automation Profile (MAP) (see Section 6.3.2.3).

The TOP specification [Thacker 1987] defines a functional network for distributed information processing for technical and business functions. TOP Version 1.0 (November 1985) is summarized in Table 7. It provides for Carrier Sense Multiple Access/Collision Detection (CSMA/CD) and Token Bus LANs using the connectionless X.25 Internet Protocol and the Class 4 transport protocol. FTAM is supported at Layer 7.

TOP Version 3.0 was released in 1989, and it is expected to have a six-year stability period before release of another version. It provides not only FTAM but also VT, Directory services, network management, and MHS at Layer 7. It further includes the ODIF (ISO 8613), Computer Graphics Metafile (CGM) Interchange Format (DIS 8632), Product Definition Interchange Format (PDIF), and the GKS interface (ISO 7492). IGES Version 3.0 from ANSI [ANSI DP ANS Y14.26M-1986, IGES 1986] is included. At the lower layers, TOP Version 3.0 provides for Token Ring LANs and for X.25 packet switching via X.21 and X.21 bus at Layer 1. TOP Version 3.0 is summarized in Table 8.

Table 7. Standards for TOP Version 1.0

Layer	References for Standards
7. Application	ISO 8571 (FTAM)
6. Presentation (Null Layer)	(ASCII and binary encoding)
5. Session	ISO 8327
4. Transport	ISO 8073 (Transport Class 4)
3. Network	ISO 8473 (Connectionless and for X.25--Subnetwork Dependent Convergence Protocol, SNDCP)
2. Data Link	ISO 8802/2 (Type 1, Class 1 Logical Link Control)
1. Physical	ISO 8802.3 (CSMA/CD Media Access Control) ISO 8802.4 (Token Bus Media Access Control)

The international organization, Open Systems Interconnection for Technical and Office Protocol (OSITOP), has been examining architectural issues and has produced a position paper on a solution for connection-oriented network service (CONS) and

connectionless-oriented network service (CLNS) internetworking (see Sections 3.2.2 and 6.2.2). This paper reaches the following conclusions:

- It is not realistic to sidestep the CONS vs. CLNS issue by expecting that one of the two incompatible sets of protocols (CONS or CLNS) be abandoned or by accepting the existence of two non-communicating OSI islands.
- Three solutions are valid, although not architecturally correct according to OSI principles:
  - The "265" internetworking function (based on TP4 over CONS)
  - A Distributed System Gateway (DSG)
  - A Multi-System Distributed System Gateway (MSDSG)
- OSITOP recommends the MSDSG solution.

SC21/WG6 is reportedly preparing a technical report that is based on the definition of an MSDSG [OSN 1989].

Table 8. Standards for TOP Version 3.0

Layer	References for Standards
7. Application	ISO 8571 (FTAM) CCITT X.400-1984 (MHS) ISO 9041 (VT, subset VT-B) ISO 8613 (ODIF) ISO 8632 (CGM) ISO 7492 (GKS) ISO 9594 (Directory) ISO 9595 and 9596 (Network Management) ISO 8649 and 8650 (ACSE)
6. Presentation	ISO 8823
5. Session	ISO 8327
4. Transport	ISO 8073 (Transport Class 4)
3. Network	ISO 8473 (CLNP, SNDCP) CCITT X.25 PLP
2. Data Link	ISO 8802/2 (Type 1, Class 1 Logical Link Control) CCITT X.25 HDLC (LAPB)
1. Physical	ISO 8802.3 (CSMA/CD) ISO 8802.4 (Token Bus) !SO 8802.5 (Token Ring) CCITT X.21 and X.21 bus (Packet Switching)

PLP: Packet Level Protocol
HDLC (LAPD): High Level Data Link Control (Link Access Precedure Version D)

3.4.3.7 Multivendor Integration Architecture (MIA)

Nippon Telegraph and Telephone Corporation (NTT) has announced the introduction of its Multivendor Integration Architecture (MIA). The architecture, developed together with NTT Data Communications Systems (NTT DATA) and five computer vendors (IBM Japan, Digital Japan, NEC, Hitachi, and Fujitsu), will enable the creation of systems composed of different vendors' computers. The architecture has been developed with the intention of providing a multivendor system that users will find easy to use. The information processing system software consists of an operating system with user programs, databases, and interface programs installed for connecting terminals and other equipment. In developing MIA, deferment was given to international standards such as program language specifications and communication protocols that have been time-tested. In areas that have not yet been standardized, the emphasis was on determining what would be necessary from the user's standpoint. In adopting the specification, efforts were focused on either expanding the international standards or on adopting *de facto* standards and specifications proposed through joint research. MIA consists primarily of three interfaces common to vendors [OSN 1991a]:

- Application Program Interface (API). The interface located between basic software and application programs which sets the specifications for three programming languages (Cobol, Fortran, and C) and the database language SQL, based on ISO and ANSI standards. An interface called the Structured Transaction Definition Language (STDL) was newly specified for the communication access interface and user access interface for distributed transaction processing.
- System Interconnection Interface (SII). This prescribes a communication protocol consisting of four types of upper-layer protocol specifications: file transfer, mail transfer, distributed transaction processing, and network management. The lower layer protocol specifications are also prescribed based on Internet and OSI.
- Human Interface (HUI). MIA uses three types of human interface specifications from OSF/MOTIF, OPEN LOOK, and IBM's Common User Access (CUA)[7]. These three interfaces, which are becoming industry standards, are used with UNIX and IBM's OS/2.

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[7] CUA is the user interface portion of IBM's Systems Application Architecture (SAA).

3.4.3.8 EWOS Profiles for the Open System Environment (OSE)

EWOS has issued a draft document on OSE profiles (EWOS/TA/91/68, April 17, 1991). If approved, it would be forwarded to ISO's SGFS for functional standardization. Table 9 shows the proposed taxonomy for OSE profiles:

Table 9. EWOS Profiles for the Open System Environment

POEnn	Open System Environment Profiles		
	POE0	Base Environment	
	POE1	Workstation Environments	
		POE10	Terminal Environment
		POE11	Personal Workstation Environment
		POE12	Professional Workstation Environment
	POE2	Utility Server Environments	
		POE20	Electronic Message Serving Environment
		POE21	Directory Serving Environment
		POE22	Access Control Serving Environment
	POE3	Information Server Environments	
		POE30	DBMS Server Environment
		POE31	Document Serving Environment
	POE4	Transaction Processing (TP) Environments	
		POE40	Simple TP Environment
		POE41	Enhance TP Environment
	POE5	Real-time Environments	
		POE50	Real-time Environment, seconds
		POE51	Real-time Environment, milliseconds
	POE6	Supercomputing Environments	
POCaa	Open System Environment Components		
	POCA	Application Program Interfaces	
		POCAM	APIs for Management Services (e.g., APIs to access and manipulate managed objects)
		POCAU	APIs for End-User Services (e.g., FIMS API)
		POCAI	APIs for Communication Services (e.g., X.400 API)
	POCL	Look-and-Feel Definitions	
	POCF	Formats	
	POCP	Protocols	

POC: Profiles for Open System Environment Components
POE: Profiles for Open System Environments

3.5 OVERVIEW OF THE STANDARDS IN THE SEVEN SERVICE AREAS

Table 10 identifies standards potentially applicable to CCISs in the seven service areas: data exchange, data management, network, operating system, programming, security and OSI management, and user interface. The status of these standards is discussed in Chapters 4-10. An OSE profile for generic CCISs for the 1995-1997 timeframe will be developed from this set of standards.

Table 10. Overview of Standards in the Seven Service Areas

Data Exchange	Data Manage-ment	Network	Operating System	Programming	Security and OSI System Management	User Interface
Chapter 4	Chapter 5	Chapter 6	Chapter 7	Chapter 8	Chapter 9	Chapter 10
ODA/ODIF SGML EDI DTAM DFR RDT	SQL SQL2 SQL3 IRDS RDA ISAM DTP ODP DATA ELEMENT	OSI REF MODEL X.400 MHS FTAM X.500 DIR. JTM ACSE CCR ROSE RTSE RPC ASN.1 BER PROFILES GOSIP EPHOS	POSIX POSIX CONF. TESTING OSCRL UNIX OSF/1 NIST APP	ADA PASCAL C COBOL BASIC FORTRAN LISP BINDINGS CASE TOOLS CAIS PCTE PCIS IEEE SOFTWARE ENGINEERING STANDARDS	SECURITY FRAMEWORK NOSA SANISI ISO 9498-2 P1003.6 SDNS BLACKER NET MGMT CMIS CMIP CONFORMANCE TESTING ESTELLE SDL LOTOS	HCI X-WINDOWS DRIVABILITY UIMS TOOLKIT VDT TM MOTIF VT

4. DATA EXCHANGE SERVICE STANDARDS

Data exchange services transfer data that represent abstract objects such as military orders, reports, research documents, graphical items (e.g., maps and overlays, symbolic graphical data that might be produced by a simulation), and raw video (e.g., television images). Data exchange services also address product descriptions.

4.1 Document Exchange

This section summarizes standards for office document interchange architectures and formats. It addresses CCIS requirements for both formatted and unformatted documents. These requirements include [IDA 1991, 137 and 142]:

- Existing use of formatted messages in CCISs
- Reduced reliance on formatted messages in favor of direct database exchanges
- Interoperability and closer coordination with systems not traditionally used directly by commanders and their staffs
- Production and maintenance of unformatted documents on the same computers that will be used for command and control
- Electronic dissemination of unformatted documents both for review and final distribution.

ISO, CCITT, and ECMA have developed several standards for the transfer of files and documents. Harmonization of these standards efforts is one of the main topics for the Technical Study Group (TSG-1) on Interfaces for Applications Portability. The standards and their relationships are discussed in the sections that follow.

4.1.1 Office Document Architecture (ODA) and Interchange Format (ODIF)

ODA is one of two standards used for describing documents in preparation for electronic interchange; the other is SGML. ODA (ISO 8613) was originally designed for the interchange of office documents between different word processors. The equivalent CCITT Recommendations are the T.410 series (see end of Appendix E). ODA describes a document in terms of its logical structure or its layout structure or both together. The ODA standard is divided into several parts:

- ISO 8613-1, *Part 1: Introduction and General Principles* and *ISO 8613-1 DAM 1 Amendment 1: Document Application Profile Proforma and Notation and DAM 2 Amendment 2: Conformance Testing Methodology*

- ISO 8613-2, *Part 2: Document Structures*
- ISO 8613-3, *Part 3: Document Processing Reference Model*
- ISO 8613-4, *Part 4: Document Profile*
- ISO 8613-5, *Part 5: Office Document Interchange Format (ODIF)*
- ISO 8613-6, *Part 6: Character Content Architectures*
- ISO 8613-7, *Part 7: Raster Graphics Content Architectures*
- ISO 8613-8, *Part 8: Geometric Graphics Content Architectures*
- ISO 8613-9, *Part 9: Audio Content Architectures*
- ISO 8613-10, *Part 10: Formal Specifications* and *ISO 8613-10 DAM 1 Amendment 1: Formal Specification of the Document Profile and DAM 2 Amendment 2: Formal Specification of the Raster Graphics Content Architectures.*

Part 5 of ODA specifies a second method of representation and interchange, using the Office Document Language (ODL) and the SGML Document Interchange Format (SDIF). ODL is an application of the Standard Generalized Markup Language (SGML), and may be used to represent a document structure in accordance with ODA in SGML.

ISO 8613 is being adopted as an American National Standard as well. ASC Committee X3V1 - Text: Office and Publishing Systems plans to produce multiple part addenda that will provide extensions to an ANSI standard that will remain consistent with the ISO 8613 standard [X3 1991]. Some of the planned extensions and their estimated dates of completion include [OSN 1991b]:

Security	October 1990
Color	March 1991
Color	1992
Annotations and revision control	1992
Automatic generation of contents lists	1992
Business graphics	1992
Data in documents, spreadsheets	1992
Hypertext	1992
Index lists, etc.	1992
Support of form letters and serial letters	1992

Tables and table layouts	1992
Voice annotations	1992

The Profile Alignment Group for ODA (PAGODA) has been formed from the three special interest groups (SIGs) and expert groups (EGs) from the three regional OSI workshops (see also Section 6.4.1): Asia/Oceania Workshop (AOW) ODA SIG, EWOS ODA EG, and the NIST ODA SIG. PAGODA is developing ODA profiles based on ISO 8613, *Office Document Architecture (ODA) and Interchange Format (ODIF)*. The Office Document Format (FOD) provides for two types of structure in its proposed taxonomy [SGFS 1989]:

- Hierarchically related based on increasing complexity and functionality (simple, enhanced, and extended document structures). The simple document structure is intended to address the general requirements of current word processing applications. The enhanced document structure is intended to address the general requirements of emerging word processing applications that have been enhanced over current applications. The extended document structure would address the general requirements of emerging personal publishing and document processing applications.
- Content architectures for various combinations of character, raster graphics, and geometric graphics content architectures.

FODs currently under development as proposed draft International Standardization Profiles (pDISPs) (see Section 6.4.2) include the following [OSN 1991c]:

- FOD11-1 (pDISP), *Office Document Format Profile for the Interchange of Basic Functional Character Content Documents in Processable and Formatted Forms - Part 1: Document Application Profile (DAP)*
- FOD26-1 (pDISP), *Office Document Format Profile for the Interchange of Enhanced Function Mixed Content Documents in Processable and Formatted Forms - Part 1: Document Application Profile (DAP)*
- FOD36-1 (pDISP), *Office Document Format Profile for the Interchange of Extended Function Mixed Content Documents in Processable and Formatted Forms - Part 1: Document Application Profile (DAP).*

Although there is no strong user demand for ODA products currently, predictions are that over the next 5 years ODA has the potential to satisfy growing demand for standards-based document management, particularly interchange. Three types of ODA products are available:

1. ODA toolkits -- intended to enable ODA conversion facilities to be built into products and systems with minimum effort
2. Converters -- extensions to existing products to allow them to take part in ODA document interchange
3. Native products -- applications that implement document processing functions that conform to ODA standards.

Six major international computer companies recently formed the Open Document Architecture Consortium (ODAC) to develop a toolkit of software that conforms to the ISO ODA standard. The companies are Digital, ICL, Siemens Nixdorf Informationsysteme, Groupe Bull, IBM, and Unisys. The toolkit is expected to be available in 1993 [OSN 1991b]. In addition, Apple Europe has made available an ODA toolkit called WOPODA.

Bull, Siemens-Nixdorf and Xerox offer ODA converters as part of their more comprehensive office systems products. Beta test versions of word processor converters and native ODA editors are in use on personal computers and Apple MacIntoshes.

ODA has been the subject of visible interworking demonstrations both in Japan and Europe. Cooperative activity in Europe has included the PODA (piloting ODA) project which, in 1990, as one of its products demonstrated the interchange of integrated text and graphics documents between participants systems using X.400 electronic messaging. Moreover, IBM recently announced that it will adopt the ODA standard instead of the revised form of its own Mixed Object Document Content Architecture (MO:DCA). Microsoft has also just declared its intention to support ODA and have an ODA Manager based around its Microsoft Word product [OSN 1991d].

4.1.2 Standard Generalized Markup Language (SGML)

SGML formalizes document markup, making the document system and processing independent. It is an architecture-free and application-free language for managing structures and is designed for full multi-media database publishing. SGML is a meta-language, providing the rules for designing and applying a system of markup tags rather than the specific set of tags. As noted above, ODL is a set of rules in ODA for using SGML to represent documents. The SGML standards are:

- ISO 8879, *Standard Generalized Markup Language (SGML)*
- TR 9573, *SGML Support Facilities--Techniques for Using SGML*
- ISO 9069, *SGML Support Facilities--SGML Document Interchange Format*

- ISO 9070, *SGML Support Facilities--Registration Procedures for Public Text Owner Identifiers*
- TR 10037, *SGML and Text-Entry Systems--Guidelines for SGML Syntax-Directed Editing Systems.*

Accredited Standard Committee X3 recently announced the second public review of X3.190-199X, Conformance Testing for SGML. The draft standard addresses the construction and use of test suites for verifying conformance of SGML systems (see also Section 9.4). Its provisions assist those who build test suites, those who build SGML systems to be evaluated by such suites, and those who examine an SGML system's performance on a test suite as part of the process of selecting an SGML tool [X3 1991a].

Three standards related to SGML are:

- CD 10179, *Document Style Segmentation and Specification Language (DSSSL)*
- CD 10180, *Standard Page Description Language (SPDL)*
- MIL-M-28001A, *Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text,* 20 July 1990 (CALS application of SGML). Revision B is expected to be complete in late 1992.

Some people believe that these standards, when used with SGML and viewed as a group, will comprise a much more comprehensive information management architecture than that envisioned by ODA [Terrell 1990]. SGML is also being extended to deal with hypermedia/time-based document interchange. The HyTime standard, *Representation of Duration and Synchronization in Time-Dependent Documents*, under development by ANSI X3V1.8M (Project 749-D) and ISO (CD 10744) is a notation to describe hypermedia. Object-oriented methods are at the heart of another similar standards effort, run by the Multimedia and Hypermedia information coding Experts Group (MHEG) [Fox 1991].

SGML has been chosen by the DoD as the documentation standard for its Computer Acquisition Logistics Support (CALS) strategy. This strategy is designed to take defense information from its current paper form to a totally electronic mode over the next decade. MIL-M-28001A establishes the requirements for the digital data form of technical publications. Data prepared in conformance to these requirements will facilitate the automated preparation, storage, retrieval, exchange, and processing of technical documents from heterogeneous data sources. The requirements set forth by this specification include:

- Procedures and symbology for markup of unformatted text in accordance with this specific application of SGML
- SGML-compatible codes that will conform a technical publication to specific format requirements
- Output control codes that will conform automated document processing functions to a uniform structure.

MIL-M-28001A establishes the requirements for the digital forms of all U.S. DoD technical publications using SGML. Data files satisfying the requirements of this specification will be one of two types: Type I - MIL-M-38784B conforming technical manuals and Type II - technical manuals conforming to other military specifications. Documents prepared in accordance with MIL-M-38784B and MIL-M-28001A must conform to the document type definition (DTD) defined in Appendix A and the output specification in Appendix C of MIL-M-28001A. The DTD and output specification for a MIL-M-38784B conforming manual do not have to be delivered with the tagged text. Technical manuals conforming to other military specifications may develop their own DTD but must use only those tags in the baseline tag set defined in Appendix B of MIL-M-28001A. In this case, the DTD must be delivered with the publication along with a compatible output specification.

MIL-M-28001A addresses the five steps in the publication preparation process:

(1) Creating a DTD for publication control

(2) Authoring the publication and inserting SGML markup tags

(3) Verifying the syntax according to the rules of SGML

(4) Using the output specification to compose the document so that produced copy corresponds to the proper formal and style

(5) Generating a text presentation metafile in SPDL to drive the display device.

The heart of MIL-M-28001A is found in its appendices. Appendix A specifies the role played by the DTD in an SGML implementation; a general description of DTD structure and content; the specific DTDs available for use in authoring, validating, and verifying an SGML-tagged technical document; and procedures for DTD development. The appendix introduction provides an overview of the concepts behind the SGML standard, a brief tutorial on reading an SGML DTD, guidelines for using SGML tags, and DoD's SGML declaration. Two DTDs are also presented in Appendix A. This first DTD is for use when preparing a document that conforms with MIL-M-38784B. The second uses the same elements as the first DTD with the addition of more subordinate paragraphs and steps.

This DTD may be used for MIL-M-38784B non-conforming documents or as a model for the development of a more appropriate DTD. Both DTDs allow for four types of non-SGML data: IGES data, CGM data, CCITT Group 4 data, and system-generated data.

Appendix B of MIL-M-28001A contains an alphabetical listing of all elements contained in the DTDs presented in Appendix A. Appendix C is a stand-alone document. It includes a document output specification (format and style guide) to be used for all applications of this specification. Although the format default values are set according to MIL-M-38784B, the values may be tailored to satisfy other format requirements. The appendix also provides an example of an SGML-coded source file and the composed sample document produced from the marked up file.

CALS, since it is an application-specific architecture oriented to technical weapons systems support documentation, may not be applicable to all of the other types of information that a generic CCIS comprises.

There is an incorrect perception that ODA and SGML are competing standards. In fact, ODA is a generic interchange architecture that uses SGML as one of its interchange formats. The other interchange format, ODIF, is specifically of use in an OSI environment because it uses ASN.1. However, both standards exist in the application layer of the OSI. Although CALS has selected SGML, it has left the door open to ODIF as well. The NIST assessment is that both ODA/ODIF and SGML enjoy an average level of consensus, and neither has much product availability or *de facto* usage. However, it evaluates ODA/ODIF as being more complete than SGML, but rates SGML as being significantly more stable and mature than ODA/ODIF [APP 1991, 35].

4.1.3 Distributed Office Applications Model (DOAM)

The Distributed Office Application Model (DOAM), ISO 10031, was established to provide a set of common principles to which all Distributed Office Applicaton (DOA) standards must adhere. The two parts of this standard, General Model and Referenced Data Transfer, do not contain any implementable protocols; they are limited to the description of models and tools to be used by DOA standards developers.

An important feature of the DOAM is the client-server model, which allows one part of an application to be implemented in a "client" machine and another part to be implemented in a "server" machine. This possibility of splitting an application allows certain central resources, such as a large database or an expensive laser printer to be shared among a number of users from their workstations.

DOA consists of the DOA model (DOAM) and two specific DOAs: Document Filing and Retrieval (DFR, ISO 10166) and Document Printing Application (DPA) (DP xxxxx). The DOAM (ISO 10031) addresses the general model, design guidelines for the peer-to-peer (Application Layer) protocol, and Referenced Data Transfer (RDT). Use of ROSE is mandatory in DOAM. The DOAM guidelines are used to define DOA objects (e.g., documents), together with object attributes and criteria for filtering those objects. The DOAM guidelines identify a set of abstract operations such as List, Read, Write, Modify, Copy, Move, Search, Create, Delete, Reserve, Unreserve, Notify, and Abandon. RDT is the mechanism used to perform transfer of objects. RDT was developed to permit "small" systems (e.g., workstations) to handle "large" objects, such as moving an object from a document store to a print service. DFR defines the structure of a document store and an associated access protocol. DPA defines an access protocol for print services. DOA is being developed by SC18/WG1 [SC21 N 3930 1989].

4.1.4 Electronic Data Interchange (EDI)

EDI provides for a standardized exchange of data between systems by a wide range of means, including exchange of magnetic tapes and the transmission of data by Telex. EDI is a standard for the data, and as such, is outside OSI (OSI standards are for the means of moving that data). EDI is intended to enable data to be interchanged *without networking* and is used mainly for interorganization communication where internetworking may be undesirable (internetworking is a primary feature of OSI).

Prior to 1985, there were two world-wide EDI standards, UN-TDI/GTDI in Europe and ANSI X12 (*An Introduction to EDI*, July 1987) in North America.[8] At that time, the United Nations tried to produce a single standard for both communities. This standard was the EDI for Administration, Commerce, and Transport (EDIFACT). The syntax for EDIFACT is now an ISO standard (ISO 9735). EDIFACT is based on ISO 646 encoding (7 bits per character--ASN.1 Basic Encoding Rules use the full range of 8 bits in each octet). A large number of standard messages have been developed based on EDIFACT, and the EDIFACT has been endorsed by many standards bodies and user groups. However, another standard, TRADACOMS, has been developed for use in the United Kingdom, based on the UN-GTDI syntax. TRADACOMS is now in wide use in the

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[8] The number of companies currently using EDI has been estimated at 15,000. Up to 13,000 of these are in the U.S. and about 1,600 in the U.K. The number of users is reported to be doubling every year. Source: International Network Services, Limited [OSN 1989c].

United Kingdom. EDI is cited in U.K. GOSIP 3.0 in the interim advice on standardization [OSN 1988b].

EDIFACT provides data structure and content standards for developing messages for use by importers, exporters, transportation firms, financial institutions, ports, customs, and other business and administrative activities (e.g., insurance, tourism, construction). EDIFACT was developed by the UN working party on Facilitation of International Trade Procedures to ensure there is only one worldwide standard for EDI. EDIFACT is ISO 9735 and uses the international standard Trade Data Element Directory (ISO 7372) [SC21 N 3885 1989]. ANSI Committee X12 guides, stimulates, and promotes the development and use of the EDIFACT standards in the United States and Canada, but EDIFACT is still not aligned with ANSI X12. The ANSI X12 Secretariat has noted that differences in syntax control segments, data segments, and data elements continue to exist between EDIFACT and the X12 standard for EDI [DISA 1990]. X12 plans to align with EDIFACT by the time of publication of Version 4 of the X12 standards in 1994 [Kornfeld 1990].

CCITT is preparing a fast-track recommendation in 1990 for electronic data interchange over X.400 (CCITT X.425). This standard will use a new User Agent protocol called PEDI that will include security services necessary to support nonrepudiation. The CCITT EDI user agent will allow CALS formats (e.g., U.S. MIL-STD-1840B, *CALS Originator File Sets and Transfer*) to be supported as body parts.

The CALS initiative is the largest and best known of the EDI proponents. CALS requires full compliance to EDI standards for digital delivery of technical information and interoperability among DoD systems beginning in January 1990. Major applications areas are automation of technical manuals, computer-assisted design, and spares acquisition. CALS standards include EDI for data interchange file management, IGES for engineering drawings, Standard Generalized Markup Language (SGML) for automated publishing, and CGM for technical manual illustrations. The standard currently being used for raster graphics representation is U.S. DoD-unique (MIL-R-28002A, 30 November 1990).

ISO/IEC JTC1 has a special working group (SWG) on EDI whose purpose is to further global interoperability among EDI application areas and use of various Information Technology standards. It has published an interim draft report on a conceptual model for EDI standards and services (ISO/IEC JTC1 SWG-EDI N 1770). The proposed "open-EDI" model intends: (1) to describe "business" relationships among participants in

EDI in a formal way, and (2) to be able to develop standards and tools supporting this description. The proposals for standardization work include [SWG-EDI 1991]:

- The methods to be followed for the description of open-EDI scenarios, and indications on the formal description techniques to be used
- The description of the functional requirements supporting the execution of the scenarios
- The abstract definition of the services needed to meet these functional requirements.

4.1.5 Document Transfer and Manipulation (DTAM)

DTAM is being developed by CCITT SG VIII. The DTAM protocols are designed to support interactive as well as store-to-store real-time end-to-end communications. They are also suitable for multi-media applications. Telematic applications are currently defined within the integrated, modular approach based on ODA (see Section 4.1.1), DTAM, and Document Architecture Operations (DAO, CCITT SG VIII). The telematic applications are Group 4 Facsimile, mixed mode, processable mode, and videotext internetworking. Each telematic application consists of equipment characteristics, document characteristics (selected from ODA), operational characteristics (optional, selected from DAO), and communications characteristics (selected from DTAM).

DTAM differs from FTAM in that the standards address different environments. FTAM satisfies requirements for the transfer of files between different file systems, including retention of generic filing information. DTAM, on the other hand, provides facilities for the storage, management, and retrieval of documents in an integrated office application environment.

Two types of telematic and office environment applications for DTAM are being developed by CCITT SG VIII and ISO JTC1 SC18: conference type and remote document handling. A service called Remote Open Document Editing (RODE) is being proposed for the telematic environment to provide real-time remote editing for content manipulation through use of ODA/DTAM. RODE is expected to fulfill such user requirements as observing changing documents; maintaining identical documents between partners, even when partners have different presentations; providing speedy manipulations; and potentially supporting participation of more than three partners. Services are being defined to enable RODE to support a desk top conference application using DFR as well as RODE [SC21 N 4342 1990].

4.1.6 Document File and Retrieval (DFR)

DFR (ISO 10166) is the responsibility of ISO/IEC JTC1 SC18/WG4. DFR is one of the office application standards defined by the DOAM (see Section 4.1.1) and shares common mechanisms with directory services and MOTIS. These mechanisms include attribute definition and filtering facilities, and they use service elements for remote operations (ROSE) and reliable transfer.

DFR also supports a "version management" mechanism. This mechanism allows a document to be declared as a new version of an existing document. When this is done, a "previous-version" attribute points to the previous version of the document, and the previous version correspondingly receives a "next-version" attribute, thus retaining the complete evolution of a given document. All versions of a document contain a "version-root" attribute indicating the first version of the document.

DFR is defined by two draft standards:

- ISO 10166-1, *DFR - Part 1: Abstract Service Definition and Procedures,* 1989
- ISO 10166-2, *DFR - Part 2: Protocol Specification,* 1989.

DFR and DTAM both handle primarily ODA documents. They differ in that DFR is not concerned with the inner content of a document, whereas DTAM is concerned with both the whole document and the inner content of the document. Further, DFR provides for filing and retrieval of (whole) documents, where as this capability is not supported by DTAM.

DFR differs from FTAM in that filing and retrieval of documents is DFR's single specific office application. An important difference between these two standards is the manner in which a document or file is identified. DFR uses a "Unique Permanent Identifier" that remains with the object for its lifetime. FTAM uniquely identifies its objects by its pathname from the root through the directories leading to it. In FTAM, if the contents of a file are moved to another directory, the pathname will change. Also, there is no analogy in FTAM of DFR's version control mechanism.

A joint meeting between SC21/WG5/FTAM and SC18/WG4/DFR in Stockholm in May 1989 concluded that, due to the different user requirements being met by the two standards, a general-store model could not be progressed [OSN 1989a].

4.1.7 Referenced Data Transfer (RDT)

RDT standards have been under development within ECMA TC32-TG5 and ISO/IEC JTC1 SC18/WG4. The abstract service definition is Part 2 of the DOAM (ISO 10031-2). The RDT protocol duplicates functionality provided by FTAM, specifically the simple, efficient transfer of unstructured data (this is provided by FTAM-3 and the FTAM Transfer Service Class). However, a minimal implementation of FTAM would not provide all the apparent RDT requirements, such as security, single/multiple use of reference, finite life of reference, and use over a single association along with the RTSE.

4.1.8 DoD Document Exchange Standards

DoD has developed the following standards for document exchange:

- DoD-STD-7935, *Automated Data Systems (ADS) Documentation,* 15 February 1983
- MIL-M-38784B, *Manuals, Technical: General Style and Format Requirements,* February 1991
- MIL-STD-1840B, *Automated Interchange of Technical Information,* March 1991
- DoD-STD-2167A, *Defense System Software Development,* 29 February 1988.

DoD-STD-7935 provides guidelines for the development and revision of the documentation for Automated Data Systems (ADS) of applications computer programs, and prescribes the standards and descriptions for each of the technical documents to be produced during the life cycle of an ADS. ADS is defined as "an assembly of procedures, processes, methods, routines, or techniques (including, but not limited to, computer programs) united by some form of regulated interaction to form an organized whole, specifically designed to make use of automatic data processing equipment." The objective of the standard is to provide managers of ADS projects with documentation of uniform format and content for review to assure the meeting of significant development milestones. It also provides ADS technicians with a standard record of technical information as a basis for coordination of later ADS development or use modification. There are eleven technical documents described in the standard: Functional Description, System/Subsystem Specification, Data Base Specification, Computer Operational Manual, Test Plan, Implementation Procedures, Data Requirements Document, Program Specification, Users Manual, Program Maintenance Manual, and Test Analysis Report. A proposed outline and text format for each document type is provided in Section 3.0 of the standard.

MIL-M-38784B is a military specification approved by the DoD for use in developing technical manuals. Technical manuals are publications that contain instructions for the installation, operation, maintenance, training, and support of weapon systems, weapon system components, and support equipment. Manuals prepared in accordance with this specification are intended for use in the operation and maintenance of equipment or for accomplishment of assigned missions. It covers the general style and format requirements for the preparation of manuscripts and reproducible copy for standard technical manuals and changes to those manuals. The only decision left to the author of a technical manual is the actual technical content of the manual; even the style of writing is specified (U.S. Government Printing Office Style Manual).

The major section of MIL-M-38784B, Section 3.2, is dedicated to format issues. The specification covers everything from the size of the paper to capitalization to suggested type styles and sizes. The specification identifies the structure of a technical manual. It specifies what will be included in the manual outline and publication divisions (volumes, parts, chapters, section and paragraphs). Paragraphs are divided into primary and subordinate paragraphs. The last sections of the specification discuss how to make changes to a technical manual, quality assurance provisions (readability, etc.) and preparation for delivery (packaging).

The purpose of MIL-STD-1840B is to standardize the digital interface between organizations or systems exchanging digital forms of technical information necessary for the logistic support of weapon systems throughout their life cycle. This standard addresses technical information and product definition data. It standardizes the format and information structures of digital data files used for the transfer and archival storage of digital technical information. The format, information structures, and transfer procedures are applicable in all cases where the information can be prepared and received in the form of American Standard Code for Information Exchange (ASCII) text files, product definition data files, raster image files, or graphics files.

Technical publications addressed by MIL-STD-1840B consist of text and associated illustrations. The files of a technical publication consist of a declaration file, text files (in ASCII) tagged to the contract (may use MIL-M-28001A), illustration files (in Initial Graphics Exchange Specification (IGES), Computer Graphics Metafile (CGM), or raster format), files in Page Description Language (PDL) form, and other files (output specification file, special word file, etc.). The standard dictates very detailed requirements for the structure, content, and order of information. For example, the declaration file must

precede the data files and provide information about the identifications, source, destination, and classification of the document. The standard also specifies the file header records for textual data, CGM data, document type definition, program descriptive language (PDL) data, IGES data, gray scale, raster data, special word, and output specification data.

DoD-STD-2167A provides the means for establishing, evaluating, and maintaining quality in software developed for weapon systems and its associated documentation. The contract agency is responsible for tailoring the software management process to meet the needs of a particular project. The data item descriptors (DIDs) associated with this standard describe a set of documents for recording information required by the management process. The standard encourages the production of deliverable data using automated techniques.

4.2 Graphical Data Exchange

Existing military CCISs support the generation and display of graphics, a capability that will continue to be required in the future. The problem is that graphics are generally not distributed. Instead the data are distributed and the graphics are regenerated at each location where they are needed. This process tends to be slow, unreliable, and expensive [IDA 1991, 152]. What is needed is a common standard intermediate form to transmit graphics such as exists in other areas of publishing [Carlson 1991]. Moreover, there is growing interest in using graphics for simulation purposes [IDA 1991, 152].

Section 4.2.1 describes two standards for exchange of graphical information products: Initial Graphics Exchange Specification (IGES) and the Standard for the Exchange of Product Model Data (STEP, formerly PDES). Standards for graphics services (e.g., Computer Graphics Metafile, Graphics Kernel System, Programmer's Hierarchical Interactive Graphics System), and Computer Graphics Interface (CGI) are addressed in Section 4.2.2.

4.2.1 Graphical Information Product Exchange

The IGES, Version 4.0, is an ANSI standard (*Digital Representation for Communication of Product Definition Data*, Y14.26M-1989) developed by the American Society for Mechanical Engineers (ASME). It is based on the work of the IGES/PDES Organization that is chaired by NIST. This group establishes information structures to be used for the (1) digital representation and communication of product definition data and (2) representation and transfer of vector graphics data used by various Computer Aided

Design and Computer Aided Manufacturing (CAD/CAM) systems. ASME is currently working on Version 5.0.

MIL-D-28000, *Digital Representation for Communication of Product Data: IGES Application Subsets*, 22 December 1987, identifies the requirements to be met when product definition data is delivered in the digital format of IGES as specified by ANSI standard Y14.26M. MIL-D-28000 is designed to be incorporated into a contract to define the technical requirements to be met when purchasing product definition data or product data in digital form. Product definition data is defined in MIL-D-28000 as:

> . . . the totality of data elements required to completely define a product. Product definition data includes geometry, topology, relationship, tolerances, attributes and features necessary to completely define a component part or an assembly of parts for the purpose of design, analysis, manufacture, test, and inspection.

The specification defines product data as "all data elements necessary to define the geometry, the function, and the behavior of a piece part or an assembly of parts over its entire life span."

MIL-D-28000 defines the technical requirements for the exchange of digital product data in specific application subsets. These subsets are technical illustrations, engineering drawings, and electrical/electronic applications. The technical illustration subset addresses entities that support the exchange of figures and illustrations normally found in a technical publication. The emphasis is on visual clarity for human interpretation. The engineering drawings subset is used to encode product data being acquired in accordance with DoD-D-1000 (*Engineering Drawings and Associate Lists*) for delivery in digital form. Exchange emphasis is on completeness, visual equivalency for human interpretation, and functionality of the received drawing model. The electrical/electronic applications subset addresses the representation and exchange of electrical and electronic products including printed wiring boards, printed wiring assemblies, hybrid micro-assemblies, cables, and wiring harnesses. Emphasis is on component and circuit element descriptions, their placement, their connectivity, and the routing of electrical paths.

MIL-D-28000 is currently undergoing revision. In addition to eliminating inconsistencies and redundancies, all references to ANSI 14.26M (based on IGES 3.0) have been updated to ASME Y14.26M (based on IGES 4.0). Moreover, references to DoD-D-1000 have been replaced with the document that supersedes it, MIL-T-31000, *Technical Data Packages, General Specifications for* [DSPO 1991].

An alternative to IGES for product data interchange is STEP, which is being developed by ISO (DP 10303). STEP was previously known as PDES, but the name was changed to differentiate it from the IGES/PDES Organization. STEP is in the draft stage and may undergo revision at any time. Many of the component specifications have not been defined, but early 1992 is projected as the goal for most of the component specifications to be ready [APP 1991, 39-40].

4.2.2 Standards for Graphics Services

This section reviews standards being developed for computer graphics. These include the Computer Graphics Reference Model, Computer Graphics Metafile (CGM), Graphical Kernel System (GKS), Programmer's Hierarchical Interactive Graphics System (PHIGS), and Computer Graphics Interface (CGI).

4.2.2.1 Computer Graphics Reference Model

The Reference Model for Computer Graphics[9] defines a basic architecture and consistent terminology for computer graphics. It addresses environment; primitives; geometry, attributes, and aspects of primitives; pictures; collections; metafiles; and archives. There are four environments: application (to which an application interfaces), virtual, logical, and physical (to which the user interfaces) [RM 1989].

4.2.2.2 Computer Graphics Metafile (CGM)

CGM standards provide a file format suitable for the storage and retrieval of picture information. The file format consists of a set of elements that can be used to describe pictures in a way that is compatible between systems of different architectures and devices of differing capabilities and design. ISO 8632 is a standard for producing a CGM in order to:

- Allow picture information to be stored in an organized way on a graphical software system
- Facilitate transfer of picture information between different graphical software systems
- Enable picture information to be transferred between graphical devices
- Enable picture information to be transferred between different computer graphics installations.

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9 This model does not appear to have been published as an ISO standard.

The CGM standards are:

- ISO 8632-1, *Functional Specification*
- ISO 8632-2, *Character Encoding*
- ISO 8632-3, *Binary Encoding*
- ISO 8632-4, *Clear Text Encoding*.

Vendors commonly use CGM as an exchange format for the storage, interchange, or output of a wide range of graphical pictures and numerous CGM implementations exist for use in federal procurements. Virtually all major microcomputer software products can generate and/or interpret CGM files. Moreover, most CGM implementations conform to the CALS Application Profile. CGM is considered to be mature and stable [APP 1991, 37-38].

A CGM test service was launched by NIST in May 1991. The service, which is a one-year trial program, will analyze a CGM file to see if it meets requirements that allow the transfer of pictures among different graphical software systems, graphical devices, and computer graphics installation. The two requirements used are FIPS 128, *Computer Graphics Metafile,* and MIL-D-28003, *CALS Application Profile.*

4.2.2.3 Graphical Kernel System (GKS)

The GKS standard, ISO 7942, specifies a language-independent nucleus of a graphics system. For integration into a specific programming language, GKS is embedded in a language-dependent layer obeying the particular conventions of that language. This layer (technically referenced as a "binding") has been defined for the programming language Ada in ISO 8651-3, based on the *Ada Programming Language* (ISO 8652). It has also been defined for the programming languages FORTRAN (ISO 8651-1), Pascal (ISO 8651-2), and C (DIS 8651-4).

GKS is considered to be a mature and stable standard. A full range of products and automated tools based on GKS has been available for various vendors for 5 or more years. However, it is limited to two-dimensional graphics [APP 1991, 41].

A 3D version of GKS is being developed in ISO. The purpose of GKS-3D is to specify extensions to GKS for defining and viewing 3D wire-frame objects. As such, the GKS-3D documents only describe additions to be made to GKS. The GKS-3D portions of the GKS standards are:

- ISO 8805, *GKS for Three Dimensions (GKS-3D) Functional Description*, October 1988, and ISO 8805/WDAD1, Addendum 1: *Name Set Addendum*, April 1987
- DIS 8806-1, *GKS-3D Language Bindings - Part 1: FORTRAN*, November 1988
- DIS 8806-3, *GKS-3D Language Bindings - Part 3: Ada*, 1989
- DIS 8806-4, *GKS-3D Language Bindings - Part 4: C*, 1989
- ANSI X3.122.5, *GKS-3D Language Bindings - LISP*.

One of the major design goals in ISO is compatibility between GKS-3D and GKS. The 2D primitives of GKS can be seen as a subset of the 3D primitives obtainable via GKS-3D. This allows a GKS-3D program to read both 2D and 3D metafiles (by forcing 2D primitives to the z=0 plane); however, GKS is unable to use 3D metafiles. Thus, upwards, but not downwards, compatibility has been achieved.

4.2.2.4 Programmer's Hierarchical Interactive Graphics System (PHIGS)

The following are the standards for PHIGS, defining language bindings for graphics interfaces:

- ISO 9592-1, *PHIGS - Part 1: Functional Description* and ISO 9592-1 AD 1 Amendment 1: *PHIGS Plus Support*
- ISO 9592-2, *PHIGS - Part 2: Archive File Format* and ISO 9592-2 AD 1 Amendment 1: *PHIGS Plus Support*
- ISO 9592-3, *PHIGS - Part 3: Clear-Text Encoding of Archive File* and ISO 9592-3 AD 1 Amendment 1: *PHIGS Plus Support*
- ISO 9592-4, *PHIGS - Part 4: PHIGS Plus*
- ISO 9593-1, *PHIGS Language Bindings - Part 1: FORTRAN Binding*
- DIS 9593-2, *PHIGS Language Bindings - Part 2: Extended Pascal*
- ISO 9593-3, *PHIGS Language Bindings - Part 3: Ada*
- DIS 9593-4, *PHIGS Language Bindings - Part 4: C.*

PHIGS is a full-functioned specification for the development of interactive two- and three-dimensional graphics applications that manage hierarchical database structures containing graphics data. Numerous PHIGS implementations are available for various hardware/software platforms. PHIGS is mature and relatively stable. No changes are planned in the next 1 to 3 years. Bindings for Fortran and Ada have been adopted.

Bindings for C and Pascal are under development. A new standard, PHIGS Plus (ISO 9592-4) has been developed, which adds shading, lighting, and other advanced graphics programming capabilities that were not included in PHIGS. Conforming PHIGS programs will be able to execute under PHIGS Plus with no change [APP 1991, 42].

4.2.2.5 Computer Graphics Interface (CGI)

ISO and ANSI have drafted a standard called the CGI, formerly the Computer Graphics Virtual Device Interface (CG-VDI). This provides a standard specification of the control and data exchange between device-independent graphics software and one or more device drivers by defining an interface to a virtual graphics device. Device dependencies are allowed in limited circumstances, such as when dealing with raster entities (this is the first graphics standard to contain explicit operations dealing with raster graphics displays). It is designed as a system level interface to provide efficient device-independent access to graphics devices and processes, but provides little error checking or error handling. Character, binary, and clear-text codings are provided. This functional specification is also supported by language bindings that specify the exact name for each operation, its parameter sequence, and data types for the parameters.

The ISO/IEC approach to defining a CGI is provided in the document, *Interfacing Techniques for Dialogues with Graphical Devices (CGI)* [SC21 N 1179]. The governing standard is DIS 9636, which has the following parts:

- Part 1: *Overview, Profiles, and Conformance*
- Part 2: *Control, Negotiation, and Errors*
- Part 3: *Output and Attributes*
- Part 4: *Segmentation*
- Part 5: *Input and Echoing*
- Part 6: *Raster*
- Part 8: *FORTRAN Language Binding of CGI (working draft)*
- Part 11: *C Language Binding of CGI (working draft).*

Although CGI is expected to be published in the final quarter of 1991, early versions of CGI implemented by IBM and AT&T have yielded workstation managers that are already becoming the industry's *de facto* standards [Wexelblat et al. 1991].

4.3 Geographical Data Exchange

This section covers the U.S. military and government, foreign, and commercial standards and standardization activities in geographic information exchange. Digital cartographic and geographic information systems have existed for several years; however, their widespread use has been impeded by difficulties in data collection and the need for information sharing standards. Perhaps the most fundamental distinction between the digital representation of cartographic data and the conventional printed graphic is the need to explicitly and unambiguously code the attributes and spatial relationships among the various data elements. Because of the massive amounts of information that must be stored, data compression is a related topic of interest (see Section 4.4).

Specific CCIS requirements for the processing and interchange of maps and geographical information include the abilities to:

- Display and transfer a working color map between two or more headquarters
- Change map features, post symbols, and have zoom capability
- Received, store, process, display, and integrate all environmental data [IDA 1991, 157].

Requirements for use of geographic information systems (GISs) for command and control are being treated in several international forums. In October 1989, a symposium on GISs was held at the SHAPE Technical Centre in The Hague. This symposium addressed requirements, standards, and implementation aspects of GISs for military application. Examples of digital data that may be required for military use of GISs are [Baybrook et al. 1990]:

- Electronic maps and tactical terrain data.
- Intelligent spatial data, to include maintaining topological relationships interactively, presenting a feature-based view of the data in which attributes can be easily requested interactively, supporting high-speed interactive queries (for which parallel processors and rule-based software may be required), and maintaining prioritized feature symbolization during creating and editing of feature data.
- Topologically structured vector data to support exchange and display of electronic maps, tactical terrain data, and user-generated queries. Features and attributes of the features are associated with points, lines, and areas. Each geographic element is captured and stored only once, together with attributes and relationships to other elements.

- Intelligence collection, data fusion, and intelligence preparation of the battlefield.
- Battle management, mission planning, tactical maneuver, and interdiction.
- Fire support and close air support.
- Antisubmarine warfare.

Digital cartographic and geographic standards generally address (1) encoding or (2) exchange. Typically they reference one another. Currently, all exchange standards are designed for removable media as opposed to establishing communication protocols for exchanging cartographic and geographic information.

There are four basic types of digital cartographic and geographic data:

(1) Digital elevation data

(2) Digital planimetric data

(3) Digital land use and land cover data, and

(4) Digital geographic names data.

Several United States Geological Survey (USGS) circulars cover these types of data:

- FIPS PUB 70-1, *Specifications for Representation of Geographic Point Location for Information Interchange,* 1986 [USGS Circular 878-B]
- FIPS PUB 103, *Codes for Identification of Hydrologic Units in the U.S. and the Caribbean Areas,* 1983 [USGS Circular 878-A]
- USGS Circular 895-B, *Digital Elevation Models*
- USGS Circular 895-C, *Digital Line Graphs from 1:24,000 Scale Maps*
- USGS Circular 895-D, *Digital Line Graphs from 1:2,000,000 Scale Maps*
- USGS Circular 895-E, *Land Use and Land Cover Digital Data*
- USGS Circular 895-F, *Geographic Names Information System.*

FIPS PUB 70-1 specifies a uniform format for representing geographic point location data in digital form for purposes of information interchange among data systems. It applies only to the three coordinate systems most widely used in the United States to define the position of a point that may be on, above, or below the earth's surface.

FIPS PUB 103 adopts the set of codes used to identify hydrologic units published in Geological Survey Circular 878-A. These codes identify a hydrologic system that divides the United States and Caribbean outlying areas into 21 major regions. These

regions are further subdivided into approximately 2,150 units that delineate river basins having drainage areas usually greater than 700 square miles. The codes provide a standardized base for use by water-resources organizations.

Several U.S. military specifications also cover digital geographic information exchange:

- MIL-D-89000, *Digital Terrain Elevation Data (DTED)*, 26 February 1990
- MIL-D-89005, *Digital Feature Analysis Data*
- MIL-A-89007, *Arc Digitized Raster Graphics*.

The first of these, MIL-D-89000, defines the requirements within the Defense Mapping Agency's (DMA's) DTED database, which supports various weapon and training systems. The purpose of MIL-D-89000 is to assure uniform treatment among all mapping and charting elements engaged in coordinated production and maintenance of this type of data. The U.K. MoD has related standards, *Digital Terrain Elevation Data* and *Digital Feature Analysis Data*.

The NATO STANAGs relevant to this area include:

- STANAG 3809, *Digital Terrain Elevation Data Exchange Format*
- STANAG 3985, *Preferred Magnetic Tape Standards for the Exchange of Digital Geographic Information*
- STANAG 3986, *Digital Data File Transmittal Form for Geographic Information*.

4.3.1 Digital Geographic Information Exchange Standard (DIGEST)

The 11-nation[10] Digital Geographical Information Working Group (DGIWG) is working on DIGEST. DIGEST may be submitted to ISO, but no definite plan for this has been identified. The present concern is for magnetic tape exchanges, with electronic communications exchanges possible in the future.

DIGEST is intended for standardizing exchanges of digital geographic data and making compatible the digital data products of the participating nations; the final draft of the standard was produced in October 1989. This draft was developed to accommodate the exchange of multiple data sets of different data structures using a single format. DIGEST

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[10] The seven member nations are France, Germany, Italy, the Netherlands, Norway, the United Kingdom, and the United States. The four active observers are Belgium, Canada, Denmark, and Spain.

has two parts. The Generic Standard is supplemented by the Minimum Standards Specifications, which are single-data-structure oriented subsets of the Generic Standard. Whereas the generic standard contains the necessary file, record, field, and subfield definition and implementation details to exchange all data structures supported by the standard, each minimum standard specification is geared towards one particular data structure and serves as the basis for the exchange of data only in that structure. The current standard supports the following [Schneider 1990]:

- Vector topologically structured data, which includes association of features with individual nodes (e.g., water tower), edges (e.g., two-lane highway with an asphalt surface), faces (e.g., forest of deciduous trees), and collections of features associated to nodes, edges, and faces (e.g., Route 1 for a series of line features or city for a collection of three types of features).
- Color-coded and red-green-blue (RGB) coded raster data:
  - An RGB raster image is a collection of red, green, and blue color bands, which when combined for display purposes form the original color of the source graphic.
  - A color-coded image represents each unique color of a scanned graphic as a series of pixels which represent the information on the original source graphic that utilized that color.
  - The raster structure supports use of subsets and merged sets.
  - The raster structure also supports user-defined parameters to indicate scan direction and row and pixel sequencing, which are required for exchanging data derived from scanners that have different capture methods.
- Feature Attribute Coding Catalog (FACC) for feature identification:
  - Features are associated with spatial coordinates or sets of coordinates.
  - Attributes may be associated with features and may serve to designate width, length, material composition, etc.
  - The initial version of the FACC has 300 feature codes and 125 attribute types with associated values. The FACC includes a recommended attribute set for each feature code.
- Transmittal Header File to describe characteristics of the entire transmittal (e.g., originator, edition of the exchange specification used, number of data sets in the transmittal, and security and release information for the transmittal).
- Header information files to describe global characteristics of each data set being exchanged [e.g., quality (currency, accuracy, and completeness), source, projection type, coordinates of the geographic limits of the data set, data

structure type]. Qualities can be associated with features and attributes as well as with data sets.

- ISO media standards [using ISO 9660 for Compact Disk-Read Only Memory (CD-ROM) and ISO 1001 for magnetic tapes].
- Security labeling.
- Format implementation compliant with ISO 8211, *Specification for a Data Descriptive File for Information Interchange.*

Standards for two other data structures are being developed for the 1990 version of DIGEST: matrix (to support exchange of elevation data) and spaghetti vector (to support exchange of non-topological vector data).

DGIWG's position is that DIGEST data should be exchanged between map-producing agencies, such as the Defense Mapping Agency (DMA), and not between operational units. Standards governing exchanges between field systems are the responsibility of the system development organization. This is a traditional view in military systems development organizations and leads to substantial interoperability problems, particularly intra-national. The official position notwithstanding, the DGIWG is encouraging the distribution of DIGEST by its member nations to the widest possible audience, including the military services and civilian users.

4.3.2 Geographic Document Architectures

The Directorate of Cartography at the Canadian National Defence Headquarters has proposed that geographic exchange standards be built on a document architecture similar in scope to ODA (see Section 4.1.1). This architecture would address, as does DIGEST, a range of physical media such as magnetic tape and CD-ROM. It would also address exchange of partial data sets and geographic "document" organizations. Unlike DIGEST, the architecture would not attempt to define the sets of feature codes and attributes, which are seen as dependent on political jurisdiction and intended use. For example, Canada must incorporate more geographic ice feature types in hydrographic charts than many other countries. The proposed architectural concept views the architecture as a vessel that carries various properly labeled containers of information. Specification of the channels for transporting the vessel are left, as with ODA, to OSI or other means outside the scope of the architecture. Encapsulation of data for telecommunications would use ASN.1 (ISO 8824 and 8825) and for physical media interchange by ISO 8211. Coding of the information would use such presentation standards as ASCII or ISO 646 for basic text;

ISO 6937, *Supplementary Characters*, for accents to the text, other alphabets (e.g., ISO 2375, *Non-Latin Alphabets*), and ISO 9292, *Picture Coding*, for pictorial information [McKellar 1990].

4.3.3 SIMNET Common Geographic Data Model

The U.S. SIMNET program has developed a geographic data model to integrate such heterogeneous data types as digital terrain models, traditional maps, and satellite and aerial imagery and such specialized tools as digital imagery workstations, GISs, relational DBMSs, and high-performance graphics workstations. The data model was defined using ASN.1, which provides a concise, unambiguous means of specifying abstract data types. The current specification, SIMNET Database Interchange Specification [Lang et al. 1989], recasts the specification of the data model into a relational data framework in order to take advantage of relational database management and query capability.

The data model represents features in spatial and non-spatial components that can be further subdivided for separate handling and also reassembled to recover the complete feature description. Entities in SIMNET (and many other GIS applications) are represented as objects. For example, networks are represented as collections of line segments, landcover is represented by polygons, terrain is represented by a triangulated mesh, and modeled objects as collections of points, line segments, and triangles. Classes of these object types (such as a class of tree representations) are generated for use in SIMNET data model. Further, the data model permits the enlargement of classes and addition of new classes of objects. For example, several classes of trees are required for simulation: sets of individual trees, collections of irregular groups of trees, lines of trees, uniformly wooded areas, and generalized surface vegetation.

The spatial model represents the physical aspects, including their visual appearance and the intervisibility of pairs of objects (one hides a part of the other). The spatial model encompasses the geometric description, the location, and the orientation of an object within some spatial frame of reference. The spatial model includes aspects that are expected to change only rarely (e.g., the underlying coordinate system) and the modifications are generally only to enhance the fidelity of the representation or the performance (e.g., through data compression). As in DIGEST, the spatial model is based on points, line segments, and triangles. It also includes tetrahedrons for three-dimensional objects, as well as a standard technique from algebraic topology called simplicial complexes to relate the various geometric elements. In this technique, triangles are 2-simplexes, line segments

are 1-simplexes, and the three line segments that make up a triangle are functions of the vertices of the triangle.

The non-spatial aspects for simulation may change during execution of a simulation and are therefore expected to be dynamic. These aspects are treated as attributes of objects as a whole or to a component. Examples of non-spatial attributes are color, weight, power, and composition [Lang et al. 1990].

4.3.4 IHO Committee for the Exchange of Digital Data (CEDD)

The International Hydrographic Organization (IHO) is developing standards for the exchange of digital hydrographic information. The work is being done by the CEDD. No world-wide standards have yet emerged from this work. One effort of IHO, called the North Sea Project, is establishing an electronic chart database, testing the contents of this database for electronic chart display systems, and evaluating methods of electronic navigational chart updating [Stene 1990].

4.3.5 NATO Geographic Conference

The NATO Geographic Conference meets annually (usually in June) to manage and coordinate digital geographic information production in support of NATO plans. The primary tasks are to [Matthews 1990]:

- Identify common national and NATO requirements for digital geographic information
- Recommend priorities for international cooperative production
- Recommend outline production responsibilities for national agreement
- Recommend outline rules and procedures for operational geographic support and its coordination.

4.3.6 Digital Chart of the World (DCW)

The DCW is a research and development project of the U.S. DMA to develop, refine, and establish a suite of standards that enable the exchange of spatial data on a variety of exploitation systems. The DCW will employ a topologically based vector structure and provide digital representation of land surface information on 30-40 CD-ROMs. The coverage will be world wide and the major source will be the 270 maps of the 1:1,000,000-scale Operational Navigation Chart series. The DCW will be the forerunner for deployed digital databases derived from DMA's Digital Production System (DPS), which is

scheduled to produce 31 standard products in 1991. A Map, Chart, and Geodesy Feature Data Exchange structure is being defined to archive and exchange DPS products.

4.3.7 Vector Product Standard (VPS)

This standard is currently in a prototype stage, but nearing finalization. A military standard was expected to have been issued in early 1991. Although the draft standard is being distributed to the civilian community, there are currently no plans to offer VPS as a civilian standard.

4.3.8 Spatial Data Transfer Specification (SDTS)

The United States National Committee for Digital Cartographic Standards, a multi-agency working group headed by the USGS which is responsible for most of the U.S. non-military geographic information exchange standards has issued SDTS. The DMA was an original participant in the development of this standard, but dropped out in favor of its own activities. On July 26, 1990, SDTS was submitted to NIST for approval as a FIPS. Following approval as a FIPS, the USGS is prepared to submit the SDTS to ANSI for promotion as an ANSI standard and then to ISO for promotion as an ISO standard.

The SDTS include definitions of terminology, a spatial data transfer specification, methods for reporting digital cartographic data quality, and topographic and hydrographic entity terms and definitions. The standard will allow users to transfer digital spatial data sets in a variety of formats between dissimilar computing systems. To support the SDTS, the USGS will coordinate the development of a suite of software tools to assist users in interfacing with the standard. These tools will include the capability to encode and decode the standard from user-specified data models and formats and to encode and decode SDTS data sets to ISO 8211 *(Specification for a Data Descriptive File for Information Interchange)* [McDermott 1991].

Other standards under development by USGS include:

- Aquifer names and geologic unit codes
- Classification of wetlands and wildlife services
- EPA (Environmental Protection Agency) parameter codes
- Codes for taxonomic identification of flora and fauna
- Land use and land cover codes

- Public land survey codes
- Cartographic attribute/feature codes.

4.4 Data Compression

An area closely related to map and geographic information is data compression since maps require large quantities of data. For example, at a scale of 1:1,000,000, a digitized map of the world requires 30 CD-ROMS. The Army wants maps that are 1:250,000 and 1:50,000. The use of data compression is not limited to maps however, as the use of complex computer graphics proliferates in areas such as desktop publishing, engineering, and industrial design. Currently, individual manufacturers, software developers, and computer services have adopted their own internal storage formats and data compression algorithms. What is needed is a unifying standard [Carlson 1991].

Some of the available image storage standards and commercial software implementations of data compression schemes include [Carlson 1991]:

- Utah RLE (Run Length Encoding) - University of Utah
- TIFF (Tag Image File Format) - Aldus and Microsoft
- PICT Version 2 (Macintosh) - Apple
- IFF (Interchange File Format) - Electronic Arts
- GIF (Graphics Interchange Format) - CompuServe
- TGA (Targa Image Format) - Truevision, Inc.
- Sun Rasterfile - Sun
- GKS, see Section 4.2.2.3
- CGI, see Section 4.2.2.5
- CCITT Recommendation T.4 (Fax).

These are several emerging data compression activities that may become standards:

- Joint Photographic Experts Group (JPEG). The JPEG, a joint project of IEC/ISO and CCITT, has issued a proposed standard currently referred to as the JPEG standard (CD 10918). The JPEG standard was originally conceived as a companion standard to Group 3 and 4 facsimile standards covering compression and decompression of still-frame, continuous-tone, photographic (gray scale or color) digitized images. The current JPEG Draft Specification (JPEG-8-R5 dated 1/2/90) is in its fifth revision [Haber 1991]. It comprises two parts. The first part specifies four modes of operation, the different codecs specified for those modes, and the interchange format. It also contains

implementation guidelines. It began the CD ballot process in February 1991 as CD 10918-1. Part 2 specifies compliance tests and began CD ballot in June 1991 as CD 10918-2 [Wallace 1991]. Several vendors have already introduced JPEG-compatible products [Haber 1991]. A second standard that deals with still pictures, JBIG (Joint Bi-Level Imaging Group) is also under development.

- JBIG will be used to compress bi-level images su.h as black-and-white photos or pages of text. While pixels can be eliminated without the loss being perceived in the continuous-tone images that JPEG deals with, JBIG deals with simpler images where there can be no image distortion. A final version of the JBIG standard is about 18 to 24 months away. Currently, there are no available JBIG implementations [Haber 1991]. A third proposal for video compression is under development by the Moving Picture Experts Group (MPEG).
- ISO/IEC/JTC1/SC2/WG11 committee work on MPEG (CD 11172, December 1990) began in 1988 with the goal of achieving a standard by 1990. MPEG-Video is addressing compression of video signals at 1.5 Mbits. MPEG-Audio is addressing compression of digital audio signals at rates of 64, 128, and 192 kbit/s per channel. MPEG-System is addressing the issue of synchronization and multiplexing of multiple compressed audio and video bit streams. Products are expected as early as 1992 [LeGall 1991].
- Digital Video Interactive (DVI). DVI uses a proprietary compression scheme that is backed by Intel Corporation, IBM, and AT&T. IBM and Intel are already marketing DVI products for personal computers and it has the potential to become a *de facto* standard.

JPEG's interest in data compression stems from a desire to transmit digital representations of photographs by facsimile. To achieve the desired levels of quality for both color and black and white requires large amounts of data and transmission time. The MPEG is looking at data compression techniques for motion pictures, reducing the data needed to represent each frame and taking advantage of the redundancy from one frame to the next.

4.5 Video Data Exchange

Future CCIS will depend on video technology for multimedia information exchanges, training, and intelligence gathering. CCIS may need to store and transmit such video images to analysts at distributed locations [IDA 1991, 162].

Most of the standards in this area appear to have come from the television industry (see Section 4.4). The International Radio Consultative Committee's (CCIR) Recommendation 601, *Encoding Parameters of Digital Televisions for Studios* was published in 1982.

CCITT Recommendation H.261, *Video Codec for Audiovisual Services at px64 kbit/s* (commonly referred to as the px64 standard) is a video coding standard that was approved in December 1990 A slightly modified version is under development by ANSI T1.64, *Digital Processing of Video Signals - Video Coder/Decoder for Audiovisual Services at 56 to 1,536 kbit/s*. A draft was issued in October 1990 [Liou 1991].

The real-time simulation community is currently faced with a tradeoff between standards or high-speed performance since available computing power is inadequate to support standards. MIL-STD-1379D, *Military Training Programs*, also addresses video, as does Multi-Media Extensions to Microsoft's Windows (*de facto*).

In addition, High Definition Television (HDTV) will require studio, exchange, mission, and display standards. For none of these does a single international standard seem likely. In the United States, the FCC intends to issue HDTV standards in the spring of 1993. Six alternatives are under consideration. Evaluation of alternatives is expected to be completed in 1992 [IDA 1991, 165].

4.6 Audio Exchange Standards

Integrated voice technology is another future CCIS requirement. Some possible applications include:

- Voice mail
- Multimedia documents for training and maintenance
- Computer-generated speech for "eyes-on" situations [IDA 1991, 166].

In March 1991, ASC X3 announced the approval of two new standards projects on Voice Messaging:

1. *Voice Messaging over MOTIS ISO 10021* is being developed by Task Group X3V1.4 as a standard protocol for voice messaging to permit the interchange of information objects effectively between various vendors' message systems.
2. *Standard User Interface to Voice Messaging* is being developed by Task Group X3V1.9 to provide users of voice messaging systems with a consistent mode of interaction in a way that is independent of underlying system

implementation.. The standard will apply only to Touch Tone telephones. Alternative interface technologies such as speech recognition or screen-based interfaces are not included.

The CCITT I Series of Recommendations for Integrated Services Digital Network (ISDN) (see Section 6.3.8.3 and 9.3.4) seeks to combine audio, video, and data transmission on a single system. Currently, the service is limited to a number of disconnected areas since most of the long distance trunk service has not been converted [IDA 1991, 166].

Future versions of MIL-STD-1379D (see Section 4.5) are expected to include standards for digital audio. The Interactive Multimedia Association is currently working on this. The ODA (see Section 4.1.1) is also designed to allow for extensions including additional types of content such as sound. In addition, CCITT G.721 is a standard audio encoding method.

A larger issue is that of integrating all these nascent standards efforts by developing a framework or reference model for digital multimedia. This problem has only recently been considered by ISO/IEC/JTC1. In addition to algorithms, bit streams, encoders, and decoders, both users and application programmers will need complete systems and environments. Open systems are required, each with an Interactive Multimedia Application Development/Utilization Environment including some or all of the following [Fox 1991]:

- Multimedia data capture tools
- Multimedia data editors/synthesizers
- Multimedia scripting language tools
- Multimedia data integrator/sequencer tools
- Multimedia database and storage/retrieval layout tools
- User interface development tools
- Simulation, testing, and publishing assistance tools
- Archiving, versioning, backup, and recovery tools
- Project management tools
- Run-time support environment for application use.

Developing a framework is but one suggestion of the ISO/IEC JTC1 Ad Hoc Technical Study Group on Multimedia and Hypermedia. Other tasks include:

- Discussing and recording a procedural plan for establishing multimedia and hypermedia requirements and a procedure for communicating these requirements among the relevant groups within JTC1
- Preparing a report on the general concepts and definitions related to multimedia and hypermedia and trying to reach agreement on general concepts.

The TSG on Multimedia and Hypermedia recommended allocating responsibility for the framework to JTC1/SC 18. It further recommended that JTC1/SC 18 work closely with the Multimedia/Hypermedia Experts Group (MHEG) (JTC1/SC2/WG12) in developing the Audio Visual Interactive (AVI) Scriptware work item (JTC 1 N 809) as a two part standard:

- Part 1: *Functional definition,* being the responsibility of SC 18
- Part 2: *Encoding* being, the responsibility of SC 2 [JTCI N 1161 1991].

4.7 Assessment of Coverage by Standards

In the area of document exchange, standards exist that would fulfill a CCIS's requirements. There is evidence that these standards are stabilizing as Document Application Profiles (DAPs) begin to appear. A decision that a CCIS may need to make is whether to adopt the ODL or SGML for its interchange format. While both can be used with ODA and information can be transferred between the two formats, there are some advantages to using SGML. Not only does CALS use SGML, but more commercial products are available for it than for ODL. Moreover, it is human-readable, preserves user file divisions, and is extensible to other architectures. Finally it possesses a broader information processing orientation than does ODL, which is concerned solely with document processing. An argument against using the CALS standard as a model is that it is oriented to technical weapons systems support documentation which may not be appropriate to a CCIS.

The status of technology in the area of data exchange is such that standards do not yet manage information as a database where content is encoded and structure and form attached.

U.S. EDI standards are not entirely aligned with international EDI standards, which poses potential interoperability problems.

Graphics services standards all appear to be stable and mature with a high level of consensus and product availability. However, none address the question of distributed

graphics. A common intermediate standard is needed to exchange graphics data stored on different platforms.

The remaining data interchange standards areas (geographic, data compression, video, and audio) are far less stable and mature. A lack of standards has impeded the widespread use of digital cartographic and geographic information systems. For example, standards establishing communications protocols for exchanging cartographic and geographic information do not exist. Harmonization of the emerging efforts is another potential problem. WAM will need to monitor standards developments in these areas as well as in the area of multimedia standards where standards are generally lacking. For example, one promising technology that has been crippled by a lack of standards is multimedia mail [Borenstein 1991].

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5. DATA MANAGEMENT SERVICE STANDARDS

5.1 Requirements

Data management standards support the storage, control, distribution, management, and allocation of simple data (text and numeric information) as well as complex data (complete documents, maps, charts, images, and multimedia objects). Data exchange standards (Chapter 4) permit the exchange of both simple and complex data among applications and between systems in a way that preserves the meanings and relationships in that data.

One or more standard query languages can be used as the basis of the peer-to-peer protocol for the exchange of data between CCISs. More than one data model (e.g., relational, hierarchical, image/map oriented) may be required. The information transfer services are primarily constrained by finite communications bandwidth and security.

Security is discussed in Section 9.2. Exchange mechanisms provided by the communications standards for network services are discussed in Chapter 6.

The data management services will provide mechanisms to accurately represent the meanings and relationships of the information items to be managed. These mechanisms include the database system, the conceptual schema, and CCIS domains. For each data model to be supported, these mechanisms will provide a standard way of representing the data, including support for common data definitions. (The definitions as well as the data would be standardized during the implementation phase of WAM.) An example of one type of support that could be provided is a data dictionary system, which could be used by CCISs to maintain common data definitions and representations. Another example is the data definition language (DDL) that may be provided with a database system or language. The DDL must be rich enough in its forms of expression to have attributes required of both commercial and military systems. For example, it needs to have the capability to recognize several types of hierarchy for data classification and compartmentalization and be trusted to permit access by users with varying levels of authorization for these classification levels and compartments.

5.1.1 Partitioned, Partially Replicated Database System

Data transfer services in future CCISs are expected to be provided by a partitioned, partially replicated database system. Partitioning means that the entire WAM database is

segmented into disjoint parts that are held at geographically separate locations. Some of the parts of the WAM database are copied or replicated at other locations to ensure survivability or to provide more rapid local access. A partitioned, partially replicated database provides sufficient flexibility for efficient exchange of information in a manner that minimizes usage of communication by permitting either "push" access (for updates) or "pull" access (for queries).

5.1.2 Conceptual Schema

A common conceptual schema is needed to define all WAM data related to information exchange.[11] The WAM database will be segmented or partitioned into replication domains, each owned and managed by a specified subfunctional area. Each replication domain has one master copy and may have other copies referred to as slave copies. A single component would be able to access some, but not all of the master and replication domains.

5.1.3 Domains

Each domain comprises two parts. One part (domain details) provides the characteristics and control information for the domain. Examples of possible domain details are: name, owner, home WAM component for the master domain, list of permitted users, component addresses for the replication domains, and security classification parameters. The other part of a domain (domain data) provides the values of each data item. The representations of some features of a domain, such as data item characteristics, data relationships, and data dictionaries, are implementation dependent and have therefore not been specified.

5.1.4 Required Services

The following basic services appear to be required:

- Data definition--provides a common understanding between systems on the attributes and meaning of data.
- Local queries--queries that can be satisfied by a data item or a set of items as specified in parameters supplied in the query, subject to authentication of the requestor's identity before issuing the data, such that the data resides in either a master or slave copy at the location where the query is made.

[11] The schema may not identify information managed uniquely by a headquarters or a national system.

- Remote queries--transfers, from a remote master or slave copy, a data item or a set of items as specified in parameters supplied in the query, subject to authentication of the requestor's identity before issuing the data, from a location other than the one where the query originated.
- Consistency control--ensures that any updates to values of data items in a slave copy ultimately become the same as the values in the master copies of the relevant domain; consistency control also ensures that update transactions are applied in the correct order.
- Local updating--provides for changing the values of a data item or set of data items for a domain, where the master copy is held at the same location as the one where the update originated.
- Local slave updating--provides for changing the values of a data item or set of data items for a slave domain, but without replication of the updates.
- Remote updating--provides for changing the values of a data item or set of data items for a domain, where the master copy is at a remote location; these operations are subsequently directed to all slave copies of the relevant domain.
- Integrity of replicas--ensures that each replica, together with deferred updates, can be used to replace the master domain in the event of a system failure.
- Management of distribution--supports the partitioning and partial replication of the databases.
- Recovery from failure--provides mechanisms to decide that there has been a failure, allows recovery from failure, and permit a slave copy to become a master copy.
- Change of command--supports change of location of command (COLOC) and succession of command (SUCOC) by permitting a slave to become the master and by permitting new slave copies to be designated dynamically.
- Database statistics--provides status and usage data for the system manager.
- Datab... initialization--provides for the creation and loading of initial values of a data...e and its replicas when the system is initialized.
- Standard knowledge base--document knowledge information.

In addition, the following management services appear to be required:

- Create domain--creates a new, empty domain, either as a master copy or for use as a replication copy of a domain.
- Delete domain--deletes a domain and erases all data in that domain. (When applied to a master copy it will delete all associated replication copies.)

- Transfer domain--causes, when proceeding to normal completion, the master of the domain to become a slave copy and the slave copy at a designated replication component to become the master.
- Assume domain--provides for change of ownership of a domain.
- Unassume domain--provides the capability to resolve the situation in which more than one WAM component has exercised assumption of the same domain by designating another domain as the master.
- Amend domain--provides for changing the characteristics of a domain, such as the list of users or the replication list, by the owner or other authorized user.
- Details domain--provides for query of the details or characteristics of a domain by an authorized user.
- Copy domain--copies the entire contents of a domain, both characteristics and data, to a replication copy. (Space for the copy is first created by "create domain.")
- Restore domain--allows the owner of a domain to recreate the data in the master copy of the domain by copying it from a replication copy, in support of data recovery after failure.
- Advise domain--allows a WAM component to be interrogated to see if it holds a copy of a domain. (This permits components who have lost and then reestablished communications to find out whether the replication list is correct.)

Some options for standardizing the appropriate features of domains are inherent in the discussions in the sections that follow. Some services being evaluated to provide database operations (not yet adopted) imply implementation of a relational database architecture. Examples of database operations are: select, update, delete, insert, project, product, union, intersect, difference, divide, join, and equijoin.

5.2 Standards for Database Services

This section primarily addresses the technical aspects of data management. The procedural aspects of data management are addressed in Section 5.3. The Reference Model for Data Management described below applies to both the technical and procedural aspects.

5.2.1 ISO Reference Model for Data Management

The *Reference Model for Data Management* is DIS 10032. Development began in 1988 and the DIS text was distributed in May 1991 (balloting ends in January 1992).

Issues to be resolved for this reference model include distributed operation and export-import concepts and requirements. Coordination with ODP is required.

DIS 10032 includes in the scope of data management the description, creation, modification, use, and control of data in information systems. The model provides a framework for identifying interfaces; positioning interfaces relative to each other; identifying facilities provided at each interface; identifying the process that supports each interface and, where appropriate, the specific data required for this support; positioning the use of the interfaces in terms of the information system's life cycle; and identifying the binding alternatives associated with each interface. The concepts defined in the model may be used to define the services provided by particular database management systems or data dictionary systems. The data management field of application concerns any user--human or applications program--who wants to request services for management and storage of information in a persistent manner.

SC21/WG3 is preparing a technical report, *Tutorial for Reference Model of Data Management*, that will address the following topics [IST 21 1534 1988]:

- Tutorial aspects for the Reference Model of Data Management
- Analysis of current database standards in terms of the Reference Model concepts
- Analysis of data management services using data flow diagrams
- Description of current database standards with respect to the requirements of the Reference Model.

PDTR text is expected in June 1992.

5.2.2 Data Definition and Manipulation Language Standards

There are now two data manipulation language standards approved by ISO, ANSI, and FIPS: NDL[12] and SQL.[13]

5.2.2.1 Database Language NDL

Database Language NDL (ISO 8907, ANSI X3.133-1986, FIPS 126) is an outgrowth of 1978 CODASYL specifications using a network model for a DDL and a data

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12 NDL is not an acronym; historically, the term derived from the concept of a network data language.

13 SQL is also not an acronym; historically, the term derived from the concept of a structured query language, but today represents much more.

manipulation language (DML). NDL is characterized, in part, by extensive use of logical pointers. These pointers support such facilities as FIND NEXT (push down in a stack) and FIND OWNER (pop up in a stack). The specification work was conducted from 1981 to 1986 by the ANSI X3H2 Database Committee. No follow-on standards activities are being conducted by ISO or ANSI for NDL [Deutch 1987; Gallagher 1988]. Implementations supporting NDL are rare.

5.2.2.2 Database Language SQL

SQL (ISO 9075, ANSI X3.135-1986, FIPS 127) is based on a relational database model; the specification work was conducted from 1982 to 1986 by the ANSI X3H2 Database Committee. Future work in the standards for database management systems by ISO and ANSI/X3H2 will be on distributed database processing (e.g., remote data access protocol) and extensions to SQL.

Both ISO and ANSI are working closely together and in parallel on SQL2 (ISO 9075), a follow-on standard. SQL2 was sent out for public review as X3.194-199x from November 2, 1990 through March 1, 1991. It is now being reviewed as X3.135-199x. An ISO editing meeting is scheduled for January 1992. This draft standard is an upward compatible enhancement of two existing SQL standards: *SQL with Integrity Enhancement* (ANSI X3.135-1989; ISO 9075:1989) and *Database Language - Embedded SQL for COBOL, FORTRAN, PL/1, Ada, and C* (ANSI X3.168-1989). The Integrity Enhancement Feature provides for check clauses, default clauses, and referential integrity constraints.

Since SQL2 has been stable for some time, it is anticipated that it will become an international and U.S. standard by 1992. In February 1990, FIPS 127 was revised (FIPS 127-1) to incorporate integrity enhancement and embedded SQL. FIPS 127-1 also documents guidelines and considerations for procuring SQL systems.

Work has already begun on SQL3 (WD 9075.3), which is planned to become a standard about 1995 or 1996. SQL3 would incorporate the following features:

- Generalized triggers (similar to IF...THEN statements; based on a condition of data, not time)
- Generalized assertions (given a certain condition, to trigger integrity checks on the database; e.g., to do before and after validation on values in the database)

- Recursive expressions (these allow an open-ended subordinate assertion, such as, to completely search a tree--currently, only finite queries to specified levels are permitted)
- Escape from SQL to call external features
- Basic capability for user-defined data types (the only structure in SQL is a table; this allows the user to declare a domain separate from a table)
- Support for subtables, provided through inheritance and generalization features
- Appropriate support tools for object-oriented and knowledge-based systems.

A major new facility on user-defined abstract data types, with support for object identifiers and other object-oriented features was adopted at the DBL rapporteur group. In addition, the module facility was enhanced to make it a schema object completely maintained by the DBMS and a CALL statement was added to the SQL language to call procedures in the modules. Additional efforts were made to expand the notion of updatability for table expressions using the definition of functional dependency. Working papers were discussed on how to enhance SQL to better address problems in GISs and in Full-Text manipulation [Gallagher 1991].

The ANSI standard X3.135-1986 SQL allows for two levels of compliance. Level 1 is a core standard that leaves many areas open to implementation definition. Level 2 contains many extensions over Level 1, but Level 2 still has a large number of options for implementation. Examples of facilities found in Level 2 but not in Level 1 are [Martin 1989]:

- Atomic transactions with respect to recovery
- Eighteen-character identifiers
- Table-name qualification by user-name
- Indicator variables
- Outer references
- Keyword ALL allowed in query-specifications, sub-queries, and set functions
- Updatable query-specification definitions
- Statements atomic with respect to database changes
- Not equal to comparisons (<>)
- Escape characters in the LIKE predicate
- REAL, DOUBLE PRECISION, and NUMERIC data types

- WITH CHECK OPTION on a view definition
- WITH GRANT OPTION on a privilege definition
- DISTINCT with AVG, MAX, MIN, and SUM.

NIST has established a test suite and formal testing service (April 1990) which provide a basic SQL conformance validation.

5.2.3 Remote Data Access (RDA)

RDA[14] is an ISO standard to facilitate access to databases from intelligent workstations and from other database systems. It is essentially a (standard) generalization of certain operations of database systems, file servers, and document servers. RDA will allow, with a minimum of technical agreement outside the interconnection standards, the interconnection of applications and database systems from different manufacturers, under different managements, of different levels of complexity, and exploiting different technologies. Since an application may itself be a database system, RDA can be used to support multi-database system interworking.

RDA service is designed to provide all possible valid data manipulation functions on any database. The functions needed (and available) depend on the structure and content of the database, so the definition of these functions must be accomplished at run time (not explicitly coded into software). Thus, RDA allows data management language operations to be defined and named (actually numbered) so they can be repeatedly invoked later in an application and association.

The ISO standard for RDA (DIS 9579) defines the format and meaning of messages that support this application. RDA uses common OSI services for the association control service element (ACSE)--ISO 8649 and ISO 8650, commitment concurrency and recovery (CCR) service elements--ISO 9804 and ISO 9805, and ROSE (ISO 9072) to provide the communications services. RDA can be viewed as a composition of ACSE and CCR with a specialization of the ROSE.[15] RDA needs no specific protocol of its own; it only requires additional sequencing rules and a method for handling violations of them. The Abstract Syntax Notation standards (ISO 8824 and 8825) are used in the Presentation Layer to

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14 Discussion taken from *Remote Database Access*, Tutorial, SC21 N 1927, ISO/TC97/SC21, 28 July 1987, UNCLASSIFIED; and DP 9579-1, 29 March 1990 [SC21 N 4282].

15 Application Service Elements ACSE, CCR, RTSE, and ROSE are discussed in Section 4.3.6.

define structures (data types) and rules for encoding structures so that the structures can be transmitted.

The ISO standard DIS 9579 is based on work of the ECMA Technical Committee on Databases, CCITT, and ISO SC18. ECMA TR30 (December 1985) was the starting point for RDA, and ECMA TR31 initially defined the concepts, notation, and connection-oriented mappings for remote operations. DIS 9579 has two parts:

- DIS 9579-1, *Generic Model, Service, and Protocol* [SC21 N 4282, March 1990], June 1991
- DIS 9579-2.1, *SQL Specialization* [SC21 N 4281, March 1990], June 1991

The remote operations philosophy is based on object modelling in which the functionality of an object is modelled as a set of operations available at its interface. Object modelling also includes the notion of object classes, subclasses, and property inheritance. In RDA these concepts are used to define a generic RDA, which defines a class of remote database access applications, and specific RDAs, each of which defines a subclass of RDA applications. Those properties common to all RDA applications are defined in the generic RDA. Those that relate to subclasses are defined in RDA specializations.

The generic RDA can support any data management language. One of the specific RDAs is a specification for the Database Language SQL [SC21 N 2643 1988]. Other specific RDAs to be developed in the near future are also expected to be based on the relational approach. The relationship data management language was chosen because it supports complex selection functions and multi-record operations for updating and deletion. This enables the RDA to accomplish selection processing in the database server (the place where the data is stored). This reduces the amount of unneeded data that is transferred to the client (user) and thus minimizes use of communications [SC21 N 1927 1987].

The SQL1 specialization (DIS 9579-2.1) defines the service and protocol for access to databases and supports the data manipulation functions of SQL. This is done through specifying the transfer syntax for specific data manipulation functions, as provided for in ISO 9075 for SQL database systems. The elements of the SQL (or any other) specialization are definitions for [SC21 N 3342 1989]:

- Data resources available as a result of establishing a dialogue and any constraints on opening and closing further data resources
- Data structure of a class of data objects supported

- Permissible classes of operations upon the objects
- Representation of all operations in an abstract syntax
- Representation for data passed as parameters for these operations.

The SQL specialization for RDA (DIS 9579-2.1) augments the generic RDA (DIS 9579-1) so that the two parts together define the following:

- Capabilities of an SQL database server that supports dialogues with clients
- Model of dialogues between the SQL database server and remote users
- Model of a dialogue between an RDA client and an SQL server
- Abstract service interface for the RDA SQL ASE that models the communications facilities supporting interaction between the SQL client and the SQL server
- RDA SQL ASE protocol to support the RDA SQL service
- Characteristics of application contexts that include the RDA SQL ASE
- Application contexts that support remote database access using SQL, specifically the RDA Basic Application Context and the RDA TP Application Context.

The generic RDA (DIS 9579-1) and SQL specialization (DIS 9579-2) were progressed to DIS status in May 1991. A SQL2 specialization (DIS 9579-2 WDAM 1) is expected in June 1992 [Gallagher 1991].

While there are no known RDA implementations, many SQL vendors are planning to have conforming client and server products available before RDA becomes a standard (before 1992). Vendor consortia, such as SQL-Access and X/Open, hope to have working prototypes operational in 1991 to demonstrate interoperability among different SQL users [APP 1991].

SC21/WG3 is considering standardizing some or all of the following properties of distributed database systems [SC21 N 5146 1990]--the new work would be done in conjunction with RDA:

- Single database image presented to the user
- Location transparency (includes automatic routing and transaction decomposition)
- Distributed transaction management
- Query optimization (to minimize communications flows)

- Data replication (optional)
- Local autonomy for database administration (i.e., no requirement for a single DBMS)
- Decentralized schema management
- Distributed deadlock detection/avoidance
- Extensibility (heterogeneous database)
- Concurrency management.

In October 1990, a new work item proposed creating an addendum to DIS 9579 entitled, *RDA Support for Stored DBL Statements* [ISO/IEC JTC1/SC21 N 5138]. In June 1991, WG3 recommended approval for this new work item. However, others recommended that a separate new project not be created, since the work could be accomplished as SQL enhancements instead [Gallagher 1991]. Services defined in DIS 9579-1 and DIS 9579-2 support the ability to define and repeatedly execute individual DBL statements at the Server. However, the defined DBL statement is considered part of the RDA Dialogue state, meaning that a defined DBL statement can only be used by the Client that created it and that any remaining defined DBL statements associated with an RDA Dialogue are removed before or when the RDA Dialogue is ended. An expanded "stored DBL statement" concept would:

- Allow a collection of SQL statements to be stored (and treated) at the Server as a single named object
- Permit the life of a stored collection of DBL statements to be longer than the life of an RDA Dialogue
- Allow any Client to use a stored collection of DBL statements [RDA 1990].

A CDTR, *Remote Database Access Tutorial,* [SC21 N 3343, January 1989] was planned for June 1991.

5.2.4 Information Resource Dictionary System (IRDS) Standards[16]

An IRDS is a system that provides facilities for creating, maintaining, and accessing an Information Resource Dictionary (IRD) and its IRD definition. The IRDS framework standard (ISO 10027, June 1990) provides a common basis for developing information resource dictionaries (IRDs), which are sharable repositories for the definition of the

16 Portions of the discussion of IRDS are taken from ISO 10027, *IRDS Framework.*

information resources relevant to all or part of an enterprise. Information resources may include:

- Data needed by the enterprise
- Computerized and possibly noncomputerized processes that are available for presenting and maintaining such data
- Available physical hardware environment on which such data can be represented
- Organization of human and physical resources that can make use of the information
- Human resources responsible for generating that information.

The IRDS standard does not provide a standard definition of all the above kinds of information. Rather, it provides a framework for defining such information in which the information can be represented and managed. The content of an IRD can be compared with the content of a typical application database--an application database contains data of relevance to the day-to-day operation of an enterprise. The difference is that the data is at a higher level (metadata or data about data) and may include such entities as data item types, data files, computer programs, and subsystems.

An IRDS is used to control and document an enterprise's information resources. ISO 10027, *IRDS Framework,* defines a number of concepts that are basic to data management. A *database* is a collection of interrelated data stored together with controlled redundancy according to a schema to serve one or more applications. *Database integrity* is the consistency of a collection of data in a database. *Export* is the function of extracting information from an IRDS and packaging it to an export/import file. *Import* is the function of receiving data from an export/import file into an IRDS. An *IRD* is a part of a repository managed by an IRDS in which the information resources of an enterprise may be recorded. A *value* is an abstraction with a single characteristic that can be compared with other values and that may be represented by an encoding of the value. A *data modelling facility* is a set of data structuring rules and an associated set of data manipulation rules. An *application schema* is a set of definitions that control what may exist at any time in an application.

The IRDS Framework identifies the kinds of data, together with the major processors and their associated interfaces and the broad nature of the services provided at each interface. Aspects addressed by various IRDS standards include programming language dependence, interface style, data modelling facility used, and data interchange format. Examples of processor interface styles are programmatic (such as a procedure call

interface, consisting of a sequenced set of parameters and associated binding rules for the CALL statement in a programming language); syntax for execution time interpretation; and service convention (a standard set of programming language independent conventions for specifying parameter lists and service primitives for use in an open systems environment). Examples of alternative styles for human interfaces are panels (abstract screen formats), concrete syntax (such as a command language), and graphics.

An abstract syntax is the specification of a service (such as for an interface style) by using notation rules that are independent of the encoding techniques used to represent them. An abstract syntax may be used to define a set of services without prescribing any linguistic form to be used when each service is initiated or invoked.

Examples of data modelling facilities are those based on standard database languages such as NDL or SQL, based on a non-standard database language, specific to a standard programming language (such as COBOL or PL/1), specific to a non-language standard (such as OSI Directory services), or which are non-standard data modelling facilities (such as entity-relationship modelling). Each data modelling facility is an intrinsically independent means of representing data and possibly the services that may be specified for such data.

Three types of support can be provided for a database using international standards. One is using standardized services at an interface, in which the contents of some part of the IRD are defined, together with the services by which those contents may be accessed and manipulated. The second type of support is by standardizing in precise terms the content of some part of an IRD according to some prescribed data modelling facility. The services that may be performed on that data may or may not be implicit in the general data manipulation services associated with that data modelling facility. The third type of support is the use of a standard data interchange format, designed to facilitate the interoperability of several real systems by standardizing the formats of the various kinds of messages sent from one real system to another. A data interchange format may be specific to an application.

IRDS provides for two types of user interfaces: a menu-driven (panel) interface and a command language interface. The panel interface provides for a structured path of screens (i.e., panels) by which an inexperienced user can execute IRDS functions. The command language may be used in either an interactive or batch mode. One of the facilities provided in IRDS supports the moving of data from one standard dictionary to another.

IRDS, including the command language and panel interfaces, is specified in terms of entities, relationships, and attributes. The entities represent or describe the concepts and data objects about which values are to be stored in the database. Relationships are binary associations between two entities (e.g., one contains the other). Attributes represent the properties of an entity or relationship. Each relationship and attribute is assigned a specific type. Entities can be compared if they have a common attribute with a common type. Ordered sets of attributes, called attribute groups, are also provided in IRDS. The IRDS schema that defines and controls what is permitted in a data dictionary is also defined using entities, relationships, attributes, and attribute groups. IRDS supports local and universal naming conventions through three types of entity names: access names (used with the command language), descriptive names (e.g., from a DoD-wide data dictionary), and alternate names (e.g., aliases used for the convenience of one or more nations or one or more WAM components). IRDS functions include adding, deleting, modifying, and copying entities and relationships, in addition to report writing.

The IRDS is a data dictionary standard being developed in parallel by both ISO (JTC1 SC21/WG3) and ANSI (X3H4). The standard is based on the entity-relationship model and would be applicable to Database Language NDL and Database Language SQL.

In addition to the ISO framework standard (ISO 10027), there is an ISO proposal for a *Command Language and Panel Interface* (DP 8800-1, March 1987). The project for DP 8800 was suspended until the *IRDS Service Interface* (DIS 10728) reached DIS status. The command language and panel interface are expected to be split into separate standards.

Working drafts have been prepared in two other areas: *IRDS Design Support for SQL Applications* and *IRDS Export/Import*. CD texts for both these standards are expected in December 1991. *Export/Import* is scheduled for completion in 1993 and *Support for SQL1 with Integrity Enhancement* is scheduled for completion in 1993. In addition, CD text for a new work item [SC21 N 5139, October 1990], *IRDS - Extensions*, is expected in June 1992.

The ANSI draft standard is identified as X3.138-1988. It was adopted by the Federal Government as FIPS-156 in 1989, effective October 1989. An 18-month transition period to allow industry to produce and provide IRDS products during which users could use non-conforming products ended in March 1991 [APP 1991]. While commercial products have been developed, their quality has not yet been determined because a Conformance Test Suite is not yet available. NIST projects that the Test Suite

will be available for beta testing in late 1991 or early 1992 [Goldfine 1991]. An upgrade to FIPS-156 is not expected until 1995. Most likely the revision will be influenced strongly by object-oriented data models as well as emerging repository and Computer-Assisted Software Engineering (CASE) technologies [Price 1991].

Accredited Standards Committee X3, Information Processing Systems, recently announced a development project for *IRDS Extensions to Support CASE Environment for Information Interchange*. This standard would define an IRDS, based on ANS X3.138-1988, capable of supporting the full range of IRDS applications. In particular, it would be capable of acting as the IRD in a traditional data processing environment and capable of providing the stable store necessary to support an integrated CASE environment. The standard would include both the semantics of the IRDS and a software interface suitable to the needs of active CASE and Dictionary tools. The development has been assigned to Technical Committee X3H4.2 [CSI 1990].

The U.S. standards effort is building on the ANSI and FIPS IRDS. Several efforts are nearing U.S. public review status, while one has been completed and another new work area has been initiated [Winkler 1991]:

- *IRDS Export/Import File Format.* The ANSI draft proposal for IRDS Export-Import File Format, which supports the export-import requirements identified in the X3.138, was completed in 1990 and expected to be an ANSI standard in 1991.
- *IRDS Services Interface (IRDS/SI).* The ANSI draft proposal for IRDS/SI began its initial U.S. public review in the summer of 1989. It subsequently changed direction and is now undergoing a second public review. The target date for an ANSI standard for IRDS/SI was spring of 1991.
- *Technical Report on the IRDS Reference Model.* This report will explain the relationship of the IRDS within the information environment of an enterprise. It is currently out for public review and expected to be released in 1991.
- *IRDS Naming Convention Verification.* X3H4.4 is scheduled to complete this in 1991.
- *Technical Report on Requirements for an IRDS in a Distributed Heterogeneous Environment.* This document, under development by X3H4.5, is progressing more slowly and will probably not be out until October 1991.
- *Technical Report on Integration of IRDS Schema.* This report is currently inactive. Instead, X3H4.6 is working on a *Technical Report on Model Unification for Data Repositories,* which will address the same problem but at a different level. The technical report will address the needs of IRDS users to

translate, integrate, reference, and/or use differing models or representations of enterprise information and behavior at various levels of complexity and abstraction. It will establish a framework for the analysis of models; analyze models; define the IRDS neutral unification model and its representation; reconstruct models using the unification model; develop an IRDS meta-schema; develop IRDS requirements; develop IRDS conceptual model architecture guidelines; and develop a test case. The target date is January 1993.

- *Standard on Export/Import Extensions.* X3H4 cannot progress this standard until the *Technical Report on Integration of IRDS Schema* is complete.

Unfortunately, the ANSI and ISO communities have diverged over the issue of whether relationships are permitted to have attributes (ANSI) or not (ISO). The rationale for the simpler model (no attributes) is that it would fit more easily with SQL tables. The rationale for the ANSI position is that a model permitting attributes, while more complex and more cumbersome, would provide greater flexibility. Further, a lot of existing products would be invalidated if no attributes were permitted for the relationships. A decision has recently been made by ISO that the IRDS Services standard should make use of the SQL data model and be defined in SQL terms [OSN 1990a]. While this revision brings together two major database standardization activities, it further complicates the alignment of the ANSI and ISO standards. Efforts on the part of ANSI X3H4 (IRDS) to seek reconciliation with ISO have not been successful [IST 21: 2499 1991].

5.2.5 Conceptual Data Modelling Facility Standards

5.2.5.1 Conceptual Schema

SC21/WG3 has identified five different uses of the term "conceptual schema." The following identifies the five uses and provides WG3 comments on those uses [SC21 N 4195 1990]:

- The results of an analysis of the data and possibly the processes perceivable in some real-world situation.
  - There is considerable disparity among the data analysis techniques used in various parts of the world. Some are being energetically promoted by minority groups.
  - There are rapid developments in CASE.
  - Attempts to standardize on any one technique may be premature. Such efforts should await availability of the Reference Model on Information Systems Engineering being developed by SC7/WG4.

  - Work on a conceptual data modelling facility should be considered as content of an IRDS and be conducted in accordance with the IRDS Framework (ISO 10027).

- A repository of "metadata" in which it is possible to specify declaratively 100% of the semantics of the data in a computerized information system (the 100% principle of TR 9007). The "100% principle" now adopted by ISO [SC21 N 197 1982; SC21 N 236 1985] says:

  > All relevant static and dynamic rules, law, etc., about the universe of discourse should be described in the conceptual schema. The information system cannot be held responsible for enforcing those rules described elsewhere, particularly those described in user procedures.

  - The 100% principle has had major influence on SC21/WG3 work in the development of SQL. The SQL draft proposal being progressed contains language specifications that make it possible to specify declaratively a very large percentage of the constraints on the data that a database designer is ever likely to want to define.
  - While SQL is never promoted as a means of defining a conceptual schema, it is, in this very important respect, superior to many of the approaches developed especially for the purpose.

- A data definition that has the property of being independent of its representation in storage.
  - Some standards committees have adopted the term to refer to some kind of representation of the data definition that is above the level of stored representations.
  - SQL is a language that enables the preparation of a storage independent definition of data.

- A data definition that is common to the collections of data at two separate sites, such that it can be used as a common frame of reference when exporting data from one site and importing it at another site.
  - In EDI, one needs a definition of data to be interchanged that is common to all sites involved in a set of interchanges.
  - Much of the EDI work has been concerned with the specification of standard formats for an industry area, such as banking or travel. As EDI tends to adopt a more generalized approach to standardization, the need for a common definition facility becomes apparent.

- A data modelling facility (see DIS 10032, the *Reference Model on Data Management)* that is different from and therefore "neutral" with respect to

broadly similar data modelling facilities used in commercially available database management systems.

- Data modelling facilities are also called data models; merits of various approaches are controversial topics.
- Another "neutral" approach would lead to confusion, is not required, and is not recommended by WG3.

5.2.5.2 Conceptual Schema Standardization

Work in the area of conceptual schema in ISO dates back to the early 1980s. In 1982, TC97/SC5 published *Concepts and Terminology for the Conceptual Schema and the Information Base.* This report was followed in 1985 by the *Assessment Guidelines for Conceptual Schema Language Proposals.*

SC21 held a workshop on conceptual schema and its relationship to the Common Data Modeling Facility in the Netherlands in November 1990. A subsequent workshop was held in Anaheim, California, in January 1991 where papers on some 18 different modelling methods were presented. Two of the approaches presented included the ANSI IRDS approach and the X3T2 Registering of Conceptual Schemas approach [Perez 1991].

ANSI has proposed that a new question be established in SC21 to determine the use, scope, and purpose of one or more standards for conceptual schema. The goal would be to address the need for models of a "universe of discourse." Such models are needed to clarify in a formal way the notion of a particular universe of discourse to which a standard applies (e.g., for Directory schema) and to facilitate the specification of a common universe of discourse for information exchange (e.g., for *Application Layer Structure,* ISO 9545) [SC21 N 4511 1990].

5.2.5.3 Conceptual Data Modelling Facility Standardization

Japan has proposed a new work item in SC21/WG3 for a conceptual data modelling facility [SC21 N 4280, February 1990]. The proposed standard would specify the facility to describe an application data model and the representation method of the result of the description of an application data model.

5.2.5.4 Object-Oriented Database Support

In June 1991, SC21/WG3 recommended that SQL support for objects continue to be developed via the SQL3 specification and that the Reference Model rapporteur group consider other requirements, as appropriate beyond SQL [Gallagher 1991].

5.2.5.5 Full Text Manipulation in Structured Data

SC21/WG3 is including in its work on SQL standardizing support for full text manipulation in combination with the management of structured data using SQL. SQL2 will support storage of a collection of text as a single data value, but will be capable of the complex requirements for full text manipulation [SC21 N 5141 1990].

Standardization of SQL metadata that goes beyond IRDS has been proposed. Currently, SQL is being used as both the IRDS modeling and implementation language. A new standard may be required for more general information modeling applications support, which would support metadata about classes of information other than those normally defined for data retrieval systems. Examples of data models for information modelling applications are binary entity-relationship data model such as IRDS, N-ary entity-relationship data model, and object-oriented data model. One effort being conducted in this area in SC21/WG3 is the Tool Integration Standard. Additional efforts on all of these models are now being conducted in the United States. One standards issue in this area, as noted above, is whether relationships as well as entities should be permitted to have attributes. The OSI management information model (DIS 10165-1) has a containment relationship whose constraints could be represented as attributes of a containment relationship [SC21 N 4593 1990].

5.2.6 Distributed Transaction Processing (TP) Standards

5.2.6.1 TP Reference Model

A reference model for distributed Transaction Processing (TP), DIS 10026-1, has been developed by SC21/WG5. TP service elements are viewed as pertaining to the Application Layer. While TP service elements are discussed in relation to the information and data management services, some TP service elements may be required for the communications services.

5.2.6.2 TP Requirements

The user requirements addressed by DIS 10026 are to:

- Define procedures that support distributed transactions in order to:
  - Allow a distributed transaction to be organized into a transaction tree
  - Provide multi-party coordination, including local resources

  - Allow restoration to a consistent state, following failure of the state/context of a distributed transaction and of distributed information
  - Allow the detection of failure to achieve consistency
  - Allow a distributed transaction to be restarted following successful state restoration
  - Indicate successful completion or failure of a transaction
- Provide for the delimitation of a sequence of logically related transactions
- Allow the grouping of transactions within an applications process
- Allow for access control, access control granularity on groups of TP objects, authentication, and non-repudiation
- Allow conformance testing of the protocol and delineate clearly the static and dynamic conformance requirements (through a PICS statement).

5.2.6.3 TP Standards

The main elements of TP are as follows:

- DIS 10026-1.2, *OSI TP Model* [SC21 N 5671, 5 February 1991], second DIS July 1991
- DIS 10026-2.2, *OSI TP Service* [SC21 N 5673, 5 February 1991], second DIS July 1991
- DIS 10026-3.2, *OSI TP Protocol* [SC21 N 5675, 5 February 1991], second DIS expected October 1991
- CD 10026-4, *TP PICS Proforma* [SC21 N 5794, 28 March 1991]
- CD 10026-5, *OSI TP Application Context Proforma* [SC21 N 5160, 6 February 1991].
- CD 10026-6, *Unstructured Data Transfer (UDT)* [SC21 N 5183 1990] June 1991.

Significant changes to the TP model (DIS 10026-1) made in December 1990 were removal of dynamic switching between chained and unchained transactions, thus enabling conforming systems to implement any one of three modes of operation: application-supported transaction, provider-supported chained transaction, and provider-supported unchained transaction. Provided-supported chained transactions require that each transaction within a dialogue use full two-phase commit procedures (CCR), while provided-supported unchained transactions always start with application-supported

transactions (no CCR) with explicit request for two-phase commit support for each transaction that requires provider-supported commitment.

The TP protocol document (DIS 10026-3) has been restructured into a form intended to be more easily understood with simpler descriptive techniques. In addition, there were changes to simplify and correct protocol procedures. Special care was given to the two-phase commit protocol and its use of CCR services to ensure that all collision cases were resolved [SC21 N 5603 1990].

A committee draft for a standard for *Unstructured Data Transfer (UDT) for OSI Transaction Processing* (CD 10026-6) has been developed by SC21/WG5. This standard would allow interconnection of computer systems from different manufacturers, including those under different management; of different levels of complexity; and of different technologies. UDT is not suitable outside the TP environment. The draft consists of a model, service, and protocol for UDT and an annex for the application context for UDT. CD text was issued in June 1991 [SC21 N 5183 1990] .

Draft taxonomies for TP profiles have been developed by EWOS, Interoperability Technology Association for Information Processing (INTAP), and NOIW. It is intended that the three will be harmonized fairly since they are fairly close together [EWOS 1991].

DIS 10026 will be used by the RDA standard and is being considered for use by RPC, extensions to IRDS, and extensions to FTAM. It is the first Application Layer service for distributed processing [SC21 N 4759 1990].

TP is dependent on a revised version of CCR, which was progressed in 1989. Two formal descriptions of TP have been produced, one in Estelle and one in LOTOS; both will be progressed as informative annexes to the TP protocol standard. TP activity will be conducted in coordination with work on RDA (WG3) and Application Layer standards (WG6).

5.2.6.4 TP New Work Items

Table 11 identifies the new work items that have been proposed for TP [Bainbridge 1989]. A new work item on TP security [SC21 N 5176 1990] is intended to expand the TP model, service, and protocol (DIS 10026-1,2,3) to provide a secure environment for distributed transaction processing interactions involving multiple open systems. PDAD text is expected in 1993, DAD in 1994, and AD in 1995.

A new work item was accepted by JTC1 for Data Transfer for OSI TP. Included in the scope of this work is development of TP queue services that would support transactions broken down into multiple steps. These services could also be used as the basis for a deferred transaction initiation mechanism or as a mechanism for reliable message transfer [SC21 N 5184 1990]. CD text is expected in November 1992.

Table 11. New Work Items Proposed In ISO for TP

- TP Association Management--to provide for the management of application associations in a distributed processing environment involving multiple open systems [SC21 N 5177]. PDAD to be completed in 1993, DAD in 1994, and AD in 1995.
- TP Commitment Optimization--to improve the performance and functionality of the commitment operation of a distributed transaction. Mechanisms being considered include alternate commitment initiator, commitment indication service, explicit selection of commitment coordinator, last subordinate optimization, multiple commitment initiators, real-only optimization, reversible ready, and unsolicited ready [SC21 N 4168]. PDAMs are expected in November 1992.
- TP Data Transfer--standardizes appropriate data mechanisms to support frequently occurring models of data exchange and to allow for migration to the use of OSI TP facilities [SC21 N 4166]. CD text is expected November 1992.
- TP Dialogue Recovery--the third phase of recovery (as defined in DIS 10026-1); it is required to enable Transaction Processing Service User Invocations (TPSUIs) to continue normal operation following the re-establishment of bound data consistency [SC21 N 4170]. PDAMs are expected June 1992.
- TP Heuristic Decisions--provides advisory propagation of a heuristic decision to all nodes; advisory propagation to nodes in the subtree below the node taking the heuristic decision; mandatory propagation of a heuristic decision to all nodes; and mandatory propagation to nodes in the subtree below the node taking the heuristic decision [SC21 N 4167].
- TP Savepoints--service to enable a transaction to be able to save and later restore a consistent state of all bound data under its control [SC21 N 4171]; new work item not accepted by JTC1, June 1990.
- TP Security--considers requirements for provision of a secure environment for TP in areas such as access control, auditing, authentication, confidentiality, integrity, management, nonrepudiation, replay, and revocation [SC21 N 5176, approved June 1990]. PDAD to be completed in 1993, DAD in 1994, and AD in 1995.
- TP Subtransactions -extensions to TP that would provide partial rollback and nested transactions [SC21 N 5156]. In the current TP standard (DIS 10026), all the bound data that are involved in a transaction tree for a transaction are committed together and, if the transaction fails, all the bound data are rolled back. PDAMs expected January 1993.
- TP Separate Data and Commit Associations - Amendments to parts 1, 2, and 3. PDAMs expected June1993 [SC21 N 5157].
- TP Conformance Testing. CD on suite structure and test purposes expected October 1992 [SC21 N 4172].

Sources: [Bainbridge 1989; amended May 1991 IST/21: 2525].

Work has begun on TP association management. The work is expected to produce an addendum to DIS 10026: CD text is expected in 1992, DIS text in 1993, and international standard text in 1994 [SC21 N 5177 1990]. The statement of requirements for TP association management was issued by SC21/WG5 in June 1990 [SC21 N 5171 1990]. It addresses association management objects for both application associations and

application association pools, negotiations with remote systems, pool sizing, query/status information, and manipulation of the authority to release associations.

Two approaches are being considered for using RPC and TP together [SC21 N 5172 1990]:

- With RPC as the data transfer paradigm for TP with use being made of TP dialogue management functions
- Using TP commitment functionality to complement the operation of RPC-based services (without necessarily making use of TP dialogues) to support "exactly once" semantics.

In 1989 a potentially serious problem was identified for TP. Under certain circumstances, protocol exchanges from one transaction (such as rollback) could overtake those outstanding from a previous transaction (and could therefore be interpreted by the receiving node as pertaining to the previous transaction). This can occur if lower layer expedited services are used to convey particular PDUs. The interim solution that was adopted was to avoid the use of Transport expedited data transfer services. A long-term solution to this problem is required to progress TP.

5.2.7 Open Distributed Processing (ODP) Standards

Open Distributed Processing (ODP) is a new area of standards development. Begun in 1987, the work has progressed so far in ISO that a new working group (WG7) has been formed in SC21 to progress the standards for an ODP Reference Model. The current work comprises the framework of abstractions (e.g., the nature of the different points of view of a system); functions and interfaces; and modelling.

The Basic Reference Model of ODP is being developed in SC21/WG7. It addresses the following aspects:

- Modelling distributed processing in terms of components, the services they support, their environment, and the interactions between them
- Identifying levels of abstraction at which the services and interactions can be described
- Classifying the boundaries between components and identifying the points of interaction associated with them
- Identifying generic functions performed by distributed systems
- Showing how the elements of the model can be combined to achieve ODP.

The Basic Reference Model (CD 10746) of ODP further defines levels of abstraction at which services and interactions can be defined in other standards, generalizing the concepts of service and protocol defined in the OSI Reference Model (ISO 7498). The structure of the Basic Reference Model is as follows [SC21 N 4025 1989]:

- WD 10746-1 Part 1: *Introduction*, containing a motivational overview of ODP, giving the scope, explained the key definitions (with no substantial architectural content), and enumerating required areas of standardization (not normative). [SC21 N 6083] 30 May 1991.
- CD 10746-2 Part 2: *Concepts and Modelling Tools*, defining the concepts, analytical framework, and notation for normalized description of (arbitrary) distributed processing systems (not normative but establishes requirements for new specification techniques). CD is planned for 1991. [SC21 N 6079] 30 May 1991.
- WD 10746-3 Part 3: *Framework for ODP Standards*, specifying the required characteristics that qualify distributed processing as open--these are the constraints to which ODP standards must conform. CD is planned for June 1992. [SC21 N 6080] 30 May 1991.
- WD 10746-4 Part 4: *User Guide*, describing the resulting ODP environment from the users' point of view and containing explanatory material of how ODP is intended to be viewed by system engineers designing distributed applications to be run in the ODP environment (not normative). [SC21 N 6083] 30 May 1991.
- WD 10746-5 Part 5: *Architectural Semantics, Specification Techniques, and Formalisms*. CD text expected May 1993. [SC21 N 6082] 30 May 1991.

In November 1990, Australia proposed a new work item to develop a standard entitled: *ODP Trader -- A Standard to Define the Role and Function of the Trader in Open Distributed Processing* (ODP) [ISO/IEC JTC1/SC21 N 5564, 3 January 1991]. The Trader is a component of an ODP system that supports trading interactions. A standard is needed to ensure:

- Portability of applications in an ODP environment
- Internetworking between ODP systems
- Distribution transparency in ODP systems [SC21 N 5564 1991].

The approach of SC21/WG7 is to identify and expand a number of ODP topics in parallel. The applicable documents are:

- *Topics List--November 1989 Version--for the Basic Reference Model of Open Distributed Processing*, December 1989 [SC21 N 4019]
- *List of Open and Resolved Issues--November 1987 Version*, December 1989 [SC21 N 4020]
- *Topic 1--The Problem of Distributed Processing*, March 1988 [SC21 N 2507]
- *Topic 2.2--Properties and Design Freedoms*, December 1988 [SC21 N 3288]
- *Topic 2.3--Framework of Abstractions*, December 1988 [SC21 N 3194]
- *Topic 3--Structure of ODP Standards*, March 1988 [SC21 N 2509]
- *Topic 4.1--Structures and Functions*, December 1989 [SC21 N 4022]
- *Topic 4.3--Function and Interface Definitions* [SC 21 N 4885]
- *Topic 5.1--Modelling Techniques and Their Use in ODP*, December 1989 [SC21 N 4023]
- *Topic 5.2--Formalisms and Specification*, December 1989 [SC21 N 4024]
- *Topic 7.1--Basic RM of ODP*, December 1989 [SC21 N 4029]
- *Topic 8.1--Draft Basic RM of ODP*, Part II, December 1989 [SC21 N 4025].

In addition, SC21/WG7 has prepared a set of definitions and a glossary [SC21 N 2511] and a register of documents and bibliography [SC21 N 3192].

5.2.8 Other Database Service Standards

CODASYL data management standards are the responsibility of the CODASYL Systems Committee. A report on distribution alternatives and generic architectures for distributed database systems was produced by this committee in 1980 [CODASYL 1980]. One of the two standard ISO data management languages (NDL) is based on CODASYL concepts.

ANSI standards for database architectures are produced by the Database Architecture Framework Task Group (DAFTG) through the Standards and Planning Requirements Committee (SPARC). A draft report [DAFTG 1982] from the DAFTG in 1982 provided a framework to support distributed databases, multiple data models, and data dictionaries. One concept, the ASN.1, has been specified [ISO 8824 1986; ISO 8825 1986].

In 1985, ECMA[17] issued a final draft report [ECMA 1985] for remote database access service and protocol.

CCITT does not provide standards for data management. The U.S. Government Open Systems Interconnection Profile (GOSIP, see Section 6.4.3) does not address standards for data management [GOSIP 1988].

5.3 Standards for Data Management

5.3.1 Data Element Standardization

The ISO has issued a draft proposal (DP 7826) on the representation of data elements. This draft proposal sets out standard procedures for the identification and representation of existing and new coding systems, without providing any guidance on specific coding systems.[18] It also specifies a technique for interchange of coded representations and the requirements for the administration of International Coding System Identifiers (ICSIs). This will permit the use of more than one coding system, reduce the possibility of ambiguity, reduce the need for human intervention, and diminish the time required to negotiate interchange of coded representation agreements. DP 7826 identifies three types of data element attributes: administrative, relational, and representative.

The U.S. Army has published an Army Regulation (AR 25-9) [DISC4 1988] to prescribe policies, responsibilities, and concept of operation for the management of data used in manual and automated information systems throughout the U.S. Army. This document has been coordinated with ISO, ANSI, and the NIST, as well as with the U.S. Joint Chiefs of Staff, to ensure alignment in the area of a data element naming convention. The U.S. Army plans to maintain a Service-wide data encyclopedia of information about all data elements that have gone through a standardization process and are designated as Army standard elements. AR 25-9 has been used for initial work on data element standardization for CIM. Additional information on AR 25-9 is provided in WP 7L [WP 7L 1989].

Substantial work has been done cooperatively by ISO JTC1/SC14 and ANSI X3L8 during the last 3 years. This work has resulted in an X3L8 document entitled *Coordination*

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[17] ECMA full membership is open only to companies who develop, manufacture, and sell computers in Europe. The restricted membership makes full consensus among participants in standards-making easier and quicker to reach than in ISO.

[18] ISO 646, ISO 2022, ISO 6937, and ISO 8859 are examples of standard coding system (see Appendix D, Sections I & E).

of Data Elements, which was accepted by SC14 as document N 492. The objective is for application areas to interchange data among themselves predicated on shared generic concepts that would be documented in a Data Element Concept Taxonomy [Kenworthy 1991]. The general approach to the structure of data recommended in AR 25-9 and ATCCIS WP 7L was derived from discussions with ISO JTC1/SC14 and ANSI X3L8.

The data element naming convention and rules presented in AR-25-9 were derived from an emerging standard from the NIST *Guide to Data Entity Naming Conventions* [NIST 1987], which is expected to be offered to ISO in the near future. However, the rules were expanded in ATCCIS Working Paper (WP) 7L to support the concepts and structure of data consistent with the needs in NATO, SHAPE, and ATCCIS, as well as the emerging ISO taxonomy.

5.3.2 Policy and Issues for Data Management

5.3.2.1 NACISA Policy

There is currently no data management policy for NATO. However, a draft statement was developed for the July 1990 meeting of the Information Systems Working Group (ISWG) of the NACISC that addresses data management policy [NACISC 1990]. The statement was distributed by the Secretary of the ISWG on June 1990. It is a statement of the requirement, jointly revised and refined by staff of the ISWG and ADSIA, for a NATO data management policy. Table 12 provides excerpts from that draft statement. The conclusion is as follows:

> Recognizing that there is further detailed work which will involve or indeed depend on the actions of the organizations, e.g. ADSIA, MAS, NACISA, etc., it is concluded that the ISWG should initiate, as a matter of urgency because of the advanced stage of SD&IC, the creation of a broad Data Management Policy to embrace: Data Management, Data Integrity, Data Dictionary, [and] Data Definition; and the relationship to Data Security. From this initial action, the position of Data Manipulation [and] Data Distribution should be clarified and tasking for detailed implementation identified.

Table 12. Excerpts from the 1990 Draft Statement by NACISA on the Requirement for Data Management

- The need for interoperability among fully automated information systems requires policies, procedures and standards of a different scope than currently available as NATO common interoperability standards. The resulting need is for a data management policy to ensure the data integrity throughout the NATO Interconnected Information System (NIIS), to include a NATO Data Dictionary to provide data definitions and a set of standards for database-to-database information exchange.
- Interoperability in the NIIS requires consistency and integrity of data throughout the system, which in turn requires NATO-wide data management standards. The use of invalid data or the incorrect interpretation of data by other information systems can be disastrous for any type of operations. Common and consistent definition of data that is subject to exchange is a prerequisite for data integrity. Data definitions are normally maintained in a data dictionary. Historically, data dictionaries have been tailored to the specific system being designed and the meanings have reflected the local users operational vocabulary. Emerging systems such as ACE ACCIS, ACCS, BICES, and ATCCIS have a requirement for a data dictionary. Only a NATO Data Dictionary can ensure that data integrity is maintained in the exchange among the various systems in the future NIIS.
- Elements of data management have been analysed to establish which of them, for reasons of operational interoperability, require to be subject to NATO-wide Data Management Policy. It has been concluded that the following six fall into this category to some degree:
  - Data Dictionary
  - Data Definition
  - Data Manipulation
  - Data Security
  - Data Integrity
  - Data Distribution.
- The following five elements of data management are considered not necessary to be subject to a policy, but necessary to be addressed internally in each information system. They are therefore not further considered in this policy statement:
  - Data Monitoring
  - Data Recovery
  - Data System Monitoring
  - Data Backup
  - Data Audit Trails.
- For NATO Data Management as a whole and for each of the elements identified above, a requirement exists to:
  - Define the data management element clearly,
  - Identify the policy activity necessary in its regard,
  - Identify the responsible authority for this activity, and
  - Identify the time scale, sequence and any internal/external dependencies as appropriate.

Source: [WP 60 Annex 1990].

5.3.2.2 ADSIA Recommendations

In April 1986, ADSIA revised a working paper [ADSIA 1987] on the need for standardization of data management. The following actions were recommended:

- NATO Communications and Information Systems Agency (NACISA) to identify and collect the requirements for database management systems and for standardization of database schemes, file transfers, database information exchange, and configuration management procedures
- Subsequently, the Information Systems Working Group (ISWG) to develop a NATO policy on data management and on the use of database management systems in NATO CCISs
- ADSIA to coordinate the development of technical and procedural standards for databases
- ADSIA to develop the procedural standards for database information exchange
- TSGCE SG9 to develop technical standards for database schemes and file transfer
- NACISA to control the implementation of the developed standards and NATO policy paper to ensure the interoperability of command and control systems within the NATO CCIS.

5.3.2.3 NIMP

Many aspects of data management are procedural in nature and will be controlled by procedural and not technical standards. Several of these standards are also identified below. The NATO Interoperability Management Plan (NIMP) [ADSIA 1988] specifically identifies standards and rules for representing data as information procedural standards and assigns the responsibility for these standards to the Allied Data Systems Interoperability Agency (ADSIA). To emphasize the role of data management in achieving interoperability, the NIMP states:

> In order for the information exchange to be effective, it is necessary that the meaning and relationships associated with that information [received from other facilities] is common and preserved, irrespective of the interoperability service and transmission media. A single common definition for all operational information throughout NATO is needed to achieve this goal.

5.3.2.4 SHAPE Policy

The purpose of data management in NATO is to provide methods to ensure data availability, security, integrity, quality, and interoperability, and to provide data sharing.

The *ACE Manual (AM) on Data Management,* AM 96-1-4 [SHAPE 1988], defines data as representing the elementary facts, descriptions, and qualifications about things of interest to some headquarters, unit activity, or enterprise. It further defines the role of a data dictionary as an automated tool that provides a centralized library of metadata covering all aspects of all types and structures of data residing in databases, file systems, and manual systems within an organization. AM 96-1-4 further asserts that:

- Evolution towards an ACE ACCIS will only succeed from the data management point of view by ensuring that the standardization of data definitions, the control of the data, and the maintenance of its overall integrity are systematically established on a command or site basis.
- The fundamental key to data management is the early definition and identification of data elements and, later, data fields. The definition and corresponding name should be clear, accurate, and meaningful, but reference should be given to connotation, which relates to the interpretation that bears upon the specific context of usage of data.

5.3.2.5 STC Work

In 1975, Shape Technical Centre (STC) published a Technical Memorandum (TM) (TM-776) on data management standardization for the ACE ACCIS [SHAPE 1985]. TM-776 recommends standardization of the architecture, functionality, and structure of the Data Management Subsystem (DMS) of the ACE ACCIS. These areas of standardization include data management methodologies and the tools used to design, build, and maintain the ACE ACCIS databases. TM-776 accomplished the following:

- Identified the requirement that the DMS at each ACE ACCIS node must agree on the semantics and syntax of the information exchange.
- Recommended that there be a standard ACE data definition or conceptual schema, where a schema defines all application object types, including their attributes, relationships, and static constraints, and where a database is an instance of a schema.
- Stated that a data classification method must be used that is based on the principle of sorting data according to the type of information provided by their values, independent of their use in particular databases, messages, or applications.
- Identified the need for a methodology for formal definition of data elements based on standardized terminology, including the use of naming conventions:

- A data element is defined as a basic unit of data that has a name, a definition, and a set of values for representing particular facts. A data element and its definition should not include any application or usage information.
- A method is needed for analysing, defining, and controlling data elements. This method should have three components: a type classification of data elements, syntax rules for the structure and completeness of formal definitions, and a controlled vocabulary of permitted terms for formal definitions.
- Standard data elements and relationships should be placed into an ACE common data structure.

5.3.2.6 NATO Publications on Data Management

AAP-6, *NATO Glossary of Terms and Definitions (English and French),* standardizes terminology used throughout NATO, thereby promoting mutual understanding. The criterion for inclusion is that the term be of a general military application. While earlier editions put qualifiers immediately following the term, such qualifiers are now embedded in the definition. In addition, terms and definitions are not to be composed of, nor contain, abbreviations and acronyms. A term and definition are included in the glossary only when they have been agreed upon by all nations in both English and French.

The terms defined in ADatP-2 [ADatP-2 1985], *Automatic Data Processing (ADP) NATO Glossary, English and French,* are derived from glossaries, dictionaries, and vocabularies from ANSI, American National Directory for Information Processing, ISO, International Business Machines, and ACP 167. The definitions are annotated by source and may include abbreviations, examples, notes, diagrams, accepted synonyms, contrasting terms, related terms, and cross-references for multiple uses. This information is noted when harmonization is being examined for multiple uses.

ADatP-3 (STANAG 5500) [ADatP-3 1986], *NATO Message Text Formatting System (FORMETS),* provides the rules, constructions, and vocabulary for standardized character-oriented message text formats that can be used in both manual and computer-assisted operational environments.

ACP 167 [ACP 167 1981], *Glossary of Communications-Electronics Terms,* provides definitions of terms used by communications, electronic warfare, and operational personnel for Allied networks.

5.3.2.7 Data Management Issues in EDI

The Special Working Group on Electronic Data Interchange (SWG-EDI) of JTC1 has identified a number of data management issues that require coordination within JTC1 (SCs 14, 18, 21, and 24) and with other Technical Committees (TCs) such as TC 46, 68, 154, and 184. The issues include [SC21 N 3925 1989]:

- Ensuring a complete separation of semantic and form of data elements, for which the conceptual schema is defined at a level other than the actual applications
- Accommodating different types of data representations, specifically with regard to the data models for different types of data, so as to assure logical relationships between data of different types can be expressed
- Structuring precisely the dictionaries of data elements and groupings, to include all the attributes of data elements and to permit unambiguous reference to other directories
- Assuring coherence of dictionaries across time (updating and maintenance) and sectors and also with generic dictionaries.

5.3.3 Data Management for Distributed Applications

The Workshop on Distributed Applications held by JTC1 in March 1990 noted that "very similar data management requirements are being addressed by differing standards applications" and that "potential exists for prevention of a considerable amount of duplication of effort and overlap...by increasing the extent of utilization of common aspects of data management facilities." Coordination was recommended among SC21/WG3(Database) and WG7(ODP), SC14, SC18, SC22, SC24, SWG-EDI, TC46, and CCITT SGs VII and VIII. Table 13 identifies common requirements for data structures and data models being addressed in ISO [SC21 N 4524 1990].

5.4 Assessment of Coverage by Standards

Until recently, there were very few international standards that applied to the database services other than those for SQL and NDL. Even so, the SQL standard is not very mature, and extensions will have to be agreed to and options reduced before SQL implementations can be expected to be interoperable. An example of a deficiency with SQL1 is that it does not address interactive queries to a DBMS.

ANSI and ISO are progressing different IRDS standards which could pose interoperability problems.

Table 13. Data Management Requirements Identified in ISO Relating to Data Structures and Data Models

- Federated data models
- Mapping to user-oriented data structures/operations
- Ability to support access control to data structures
- Wide range of sizes--large and small volumes of data
- Logging of operations for audit
- Ability to combine separately defined data types (static and dynamic)
- Application-oriented operations (e.g., searching)
- Support for internationalization
- Version control (including data structure modifications)
- Distribution, transparency support, and modelling location
- Handling of uninterpreted data
- Support of different levels of consistency and data integrity
- Ability to relate families of specifications for different levels of abstraction
- Support for recursive and structured definitions
- Persistent storage of results of operations
- Ability to support pointer types
- Ability to support powerful query languages
- Support for Directed Acyclic Graphs (including selection)
- Support for uniqueness requirements
- Independence from programming languages and means of access
- Support of declaration of hotspots and triggers
- Choice of granularity

Source: *Consideration of the Data Management Component of Application Standards*, Workshop on Distributed Applications, SC21 N 4524, 23 April 1990.

Standards for RDA and concepts for ODA show promise for use with standardizing database services and protocols. It is too early to tell how well these standards activities will cover the WAM requirements. Moreover, technical deficiencies are holding up the progression of the RDA standard.

SC21 has identified three issues regarding its future study items, all related to databases. These issues are [SC21 N 3134 1988]:

- There is an urgent need to develop clear views on the relationships between database activity and OSI activity. Two major areas need to be addressed:
  - Relationship between IRDS work and activity on directories, and on the structure of management information
  - Relationship between export-import requirements and distributed database work, and OSI standards, in particular those to do with the storage and manipulation of information (i.e., FTAM).

- There is a need to clarify conformance requirements in relation to database standards, in particular:
  - Nature of conformance statements in database standards
  - Need for, and nature of, conformance test specification standards.
- There is a need to clarify security requirements in relation to database standards, in particular:
  - Security needs
  - Security approaches and mechanisms
  - Relation of SC20 work to database security requirements
  - Relationship of database security needs to other security work (in particular to OSI security) and to overall system security policies.

The objective of information and data management services for WAM is to provide not only data processing functionality but also support for data objects. Not all of these objects can be specified with a relational model. Therefore, SQL will not, alone, be a satisfactory standard for database interfaces in WAM. Some technical issues, together with related findings, that need to be addressed by the architecture before the adequacy of standards can be determined are:

- Degree of distribution or centralization for data management. Two classes of standards are being developed for distributed systems (Distributed Transaction Processing and Open Distributed Processing), but the basic standards work will not be completed before 1994, at the earliest. Moreover, the Distributed Transaction Processing standard cannot be progressed until a technical problem with the transport (lower layer) expedited data transfer services is solved.
- Determination of what models are required for the conceptual schema, in addition to the relational model for information items to be managed. Database languages are mature only for the hierarchical (NDL) and relational (SQL) models. The current standard for SQL does not address many important database interface services, but some of these will be standardized by SQL in 1992. Further work is required (SQL3), but this work is still in a preliminary stage, with no set scope or schedule.
- Functionality to be provided to the user for ad hoc queries. Menu-driven functionality may be adequately supported by emerging standards for user interfaces (Terminal Management and X-Windows), but direct interface to SQL may require use of nonstandard extensions. Some of these extensions may be available in products in 1995, but lack of standardization may reduce the degree of interoperability and portability of implementations.

- Need for expert system or other artificial intelligence-base interface mechanisms to the database. Standards for such interfaces have not been developed.
- The technologies to be employed, such as special-purpose database hardware (to improve, for example, access time), optical storage devices, fibre-optic communications, and high-speed local area networks. Standards in these areas are being developed but are not yet mature.

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6. NETWORK SERVICE STANDARDS

6.1 Network Service Requirements

Network services provide the standard utilities that allow applications, operating systems, and database management software executing on distributed, heterogeneous computers to achieve interoperability with acceptable performance levels. The WAM Architecture will address such topics as real-time communication; synchronization; quality of service; security; incorporation of video, audio, and data onto a single system; priority; and preemption. Network services address data communications, transparent file access, and remote process execution.

Network services provide functionality to allow different parts of a CCIS, or two CCISs, to invoke services one from another. These include data transfer protocols, services of the communications infrastructure, and services to manage data transfer and communications.

6.2 OSI Reference Model, Interworking, and Application Layer Structure

This section summarizes the elements of the OSI Reference Model, interworking of layers, and the structure of the Application Layer. It also addresses the characteristics of distributed applications and related architectural standards work.

6.2.1 Status of OSI Reference Model, ISO 7498

The OSI Reference Model has four elements: *Basic Reference Model* (ISO 7498), *Security Architecture* (ISO 7498-2), *Naming and Addressing* (ISO 7498-3), and *Management Framework* (ISO 7498-4). Connectionless-mode aspects were originally addressed as Addendum 1 to ISO 7498. Multipeer Data Transmission (MPDT) is addressed as Addendum 2 and Upper Layer Architecture (ULA) as Addendum 3.

Balloting for SC21 N 3287,[19] *Proposed Draft Addendum 2 on MPDT* (ISO 7498-1/PDAD2), ended 15 July 1989. Work in ISO on MPDT has been suspended in SC21/WG1, since the nations did not demonstrate specific interest in continuing this work. The completed work is planned to be released as a technical report. New work in ISO on MPDT may come in the form of standards for multi-party communications (MPC), defined

[19] SC21 N xxxx denotes an ISO working draft standard or technical paper distributed throughout SC21. Such drafts applicable to CCISs are listed at the end of the first section of Appendix E.

as information distribution within groups of end open systems. A May 1990 Canadian contribution to SC21 identified the basic driving forces for MPC as the coordinated interworking of more than two application processes in a single activity and use of inherently shared resources of certain subnetwork types. "Group" processing was identified as one of the next "hot topics" for standardization and was expected to include such activities as conferencing, co-authoring, sensor-based data collection, and process control--all of which involve MPC [SC21 N 4681 1990]. The U.S. requested reactivation of the MPDT project at the May 1991 meeting of WG1. The requested was rejected pending technical contributions.

ISO 7498 is being revised to incorporate general aspects, upper layers, and lower layers into ISO 7498-1, *Basic Reference Model.* A working draft of the revised text [SC21 N 5092] was distributed in November 1990 [SC21 N 5501 1990].

ISO 7498-1 is also being revised to permit routing and relaying between individual local networks in the Data Link Layer. This work is being coordinated with CCITT [SC21 N 5074 1990]. Other work includes clarifying the distinction between connectionless and connection-mode operation, aligning the service definitions for the lower layers and also for the upper layers, improving consistency of layer descriptions, adding Reset as a facility to the Data Link Layer, adding Suspend and Resume as functions in the Transport Layer, and aligning this work with CCITT [SC21 N 5095 1990; SC21 N 5096 1990]. The first draft of the revised text for ISO 7498-1 was expected to proceed to CD ballot in June 1991.

The OSI Reference Model is being supplemented by a number of other models and frameworks within the context of OSI. These include Application Layer Structure, Internal Organization of the Network Layer, and the Transaction Processing Model [SC21 N 5081 1990]. Conventions for specifying OSI service definitions are also being developed. DIS text has been distributed in ISO for a new standard, *Conventions for Service Definitions,* DIS 10731 [SC 21 N 5933 1991]. The three parts are *General Model and Conventions, Application Layer,* and *Layers 1-6.* DIS 10731 will supercede TR 8509, which provides interim guidance to users and definers of service standards.

6.2.2 Interworking of Lower Layers in OSI

The basic interworking standards used for specifying relays are the following (examples of relay profiles using these standards are given in Appendix B):

- DIS 10028-1, *Definition of the Relaying Functions of a Network Layer Intermediate System, Part 1: Connection-mode Network Service* (awaiting DIS ballot)
- CD 10028-2, *Definition of the Relaying Functions of a Network Layer Intermediate System, Part 2: Connectionless Network Service* (awaiting CD ballot)
- TR 10029, *Operation of an X.25 Interworking Unit*, March 1989
- ISO 10030-1, *End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878*, 11 October 1990
- CD 10030-2, *End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878, Part 2: PICS Proforma* (awaiting CD ballot)
- DIS 10038, *Media Access Control (MAC) Sublayer Interconnection (MAC Bridging)* (awaiting DIS ballot).

Technical Committee X3S3 of Accredited Standards Committee X3 has three MAC-related liaison projects with JTC1/SC6 underway:

- To develop a technical report that will provide a description of the representation of MAC Addresses. The report will record all values assigned for the use of Standards in one document, whereas at present this information is scattered across a number of documents [X3 1991b].
- To develop an amendment to DIS 10038 that will extend the scope to include source routing capability [X3 1991c].
- To develop a technical report that will provide guidelines for LANs implementing "source routing operation" defined in DIS 10038/PDAM2, *MAC Bridging - Source Routing Supplement* [X3 1991d].

TR 10172, *Network/Transport Protocol Interworking Specification*, 15 October 1990 [SC6 N 5906, March 1990], addresses the inability of end systems operating in the CO network protocol (ISO 8208/8878 X.25) and CL network protocol (ISO 8473) to interwork with each other. A mediating device, called the Interworking Functional Unit (IFU), is defined to perform relaying and/or conversion of protocol data units (PDUs) from one network protocol type to another. Three modes of operation are considered in DTR 10172:

- Network Layer Relay (NLR). In the NLR mode the IFU operation functions as a regular intermediate system. CL NLR operation is in accordance with ISO 8473 and CO NLR with ISO 10177 and ISO 10028.

- Passive Transport Layer Relay (PTLR). PTLR does not itself operate on the PDUs of transport connections, but passes transport PDUs received in network service data units from each end system transparently to the other end system.
- Active Transport Layer Relay (ATLR). ATLR provides an end-to-end transport service by operating a separate transport connection to each of the connected end systems and relaying data from one connection to the other.

Since the PTLR and ATLR modes of operation lie outside the scope of the OSI architecture, the technical report is not planned to be converted to an ISO standard.

Network Relay (also called Routing), however, is the most important outstanding issue in the Network Layer. The standards that describe the protocols and algorithms for routing over a connectionless network service have progressed rapidly over the last 3 to 4 years, after a slow start, and final standards and products that implement them should start appearing before the end of 1991. The equivalent work on routing for connection-oriented networks has proceeded more slowly, and it is not clear when draft standards will be published. Examples of network relay profiles appear at the end of Appendix B. Three OSI standards are of particular importance to the provision of open routing:

- ISO 8473, *Protocol for Providing Connectionless-Mode Network Service*
- ISO 9542, *End System to Intermediate System (ES-IS) Routing Exchange Protocol*
- DIS 10589, *Intermediate System to Intermediate System (IS-IS) Intra-domain Routing Exchange Protocol* (IS expected during 1991) [OSN 1990b].

Task Group X3S3.7 of Accredited Standards Technical Committee X3S3 - Data Communications is developing a draft standard describing the interworking between two packet switched data networks (PSDNs) via an X.25 link. This draft standard (Project 682-D) would typically be used for interworking between a packet switched public data network (PSPDN) and a packet switched private data network (PSPvtDN). It specifies the general addressing and routing principles associated with two PSDNs and their interworking as well as the procedures to be followed by an interworking function (IWF) that is used to connect the PSPDN and the PSPvtDN [X3 1991e].

The following comment on CL-mode and CO-mode interworking was provided to SC21 following a February 1990 meeting of CCITT SG VII regarding the proposed update to the OSI Reference Model (ISO 7498-1) [SC21 N 4559 1990]:

> The connectionless/connection-mode crossover rules currently proposed by ISO appeared, to many of the Q23/VII attendees at this meeting, to be unacceptable for use in fully supporting connectionless-mode CCITT applications, due mainly to interconnectivity problems. Many of the attendees felt that, for "across-the-board" support of connectionless CCITT applications, within the lower layers, there is a need to have common (mandatorily provided) support required that would assure interconnectivity among all connectionless-mode OSI CCITT applications. It was unanimously agreed that the concept of attempting to solve such interconnection problems exclusively through introduction of any "transport relay" concept in CCITT Recommendations is totally unacceptable.

Accredited Standards Committee X3 recently formed a new Technical Committee, X3T6, Non-Contact Information Systems Interface (NCISI). The primary goal of this committee will be to develop a non-contact standard interface between computer devices for the transfer of information. The committee is developing a standard for U.S. activities; however, it eventually intends the standard to be submitted to ANSI as a JTC1 Fast Track Candidate for approval as an international standard. The committee will review current technology in radio frequency data/communication, infrared, and similar non-contact data transfer technologies with the objective of standardizing the interface between like devices. The standard would be restricted to the interface, allowing unrestricted development of computer components on either side of the interface [X3 1991f].

6.2.3 Application Layer Concepts

The Application Layer differs from the other layers of OSI in several respects. Entities in the Application Layer are made up of a collection of application service elements (ASEs), each of which is defined by a set of service and protocol standards. These ASEs are combined in various ways to form several types of Application Elements (AEs).

Standards in the Application Layer define procedures for the support of distributed information processing. The Presentation Layer supports the Application Layer by providing facilities for representing information exchanged between AEs. The Session Layer provides the mechanisms that may be used for controlling interactions between AEs.

6.2.3.1 ISO Studies on Application Layer

In its November 1989 Strategic Plan, JTC1 directed five initial major technical studies in order to address new or expanding areas to provide a basis for planning the JTC1 long-range program. The studies of required standards are all applicable to the Application Layer:

- Defining interfaces for application portability

- Defining interfaces required for distributed systems and applications
- Integrating voice, data, text, graphics, and image information at the user application level
- Addressing the area of artificial intelligence
- Supporting modelling of user requirements.

6.2.3.2 Application Layer Structure (ALS)

ISO 9545, *Application Layer Structure*, was published by ISO in December 1989. This was based on work done by SC21/WG6. ISO 9545 defines the nature of standards in the Application Layer and the relationships among them, the architectural framework in which individual OSI Application Layer protocols shall be developed, and the categories of identifiable objects that are necessary for the specification and operation of protocols. It also relates distributed information processing activities to the standards in the Application Layer. Key concepts from the ALS are the following:

- Association (application association)--a cooperative relationship between two AE invocations for the purpose of communicating information and coordinating their joint operation. This relationship is formed by the exchange of application protocol control information using the Presentation Service.
- Application context--a set of rules shared in common by two service element (SE) invocations in order to enable their cooperative operation. The application context is an example of a shared conceptual schema. SC 21 N 5502 is a liaison to CCITT Q23/VII concerning application context negotiation during association establishment.
- Single association object (SAO)--the collection of things in an AE invocation related to a single application association.
- Single association control function (SACF)--the component of a single association object that represents the use of those rules in the application context concerning interactions among ASEs within a single application association.
- Multiple association control function (MACF)--a component of the AE invocation that coordinates the interactions among multiple associations within an AE invocation in order to provide a coordinated service.

An amendment to ISO 9545 for connectionless mode transmission has been in the working draft stage since 1988. PDAM status was expected in June 1991.

SC21 N 4903, PDTR xxxx, *Methodology and Guidelines for the Development of Application Layer Protocols,* June 1990, is being developed by SC21/WG6 to provide a discipline for the development of application protocol standards in order to generate precise specifications. It describes a step-by-step procedure for generating ASE definitions and protocol specifications. This new work item of 1988 failed but the program of work with CDTR is still active, making its status uncertain.

6.2.3.3 Extended ALS

Work on an extended ALS (XALS) model has begun (ISO 9545 PDAM 1). The purpose of XALS is to supplement ISO 9545 (*Application Layer Structure*) by providing a more complete framework for development of Application Layer protocol standards that use other Application Layer protocol standards. A central focus of XALS is extension of the architecture for use of multiple associations [SC21 N 4901 1990]. As of 15 April 1991, the amendment has achieved proposed draft amendment status [ISO 9545/PDAMI 1991].

XALS is planned to provide a revised ALS model that is significantly richer in scope and descriptive capability than is provided in ISO 9545. As a result, it will provide more options for the specification of Application Layer standards. Examples of new features being proposed for the XALS are:

- Defining application service elements (ASEs), application service objects (ASOs), and control functions. An ASO is made up of one or more ASEs and/or ASOs, and a control function. A control function is the component of an ASO that controls the interactions among ASEs and/or ASOs within the containing ASO [SC21 N 4002 1989].
- Providing guidance for ASE specifications in the areas of the reference model the ASE supports, the service definition, the abstract protocol definition, and the ASE environment requirements specification.
- Addressing peer-to-peer (application level) relationships as well as the established concept of application association, such as are used on MHS, TP, EDI, and Directory.
- Accommodating both peer-to-peer and client-server interaction styles. (ROSE supports both styles of interaction. X-Windows and DOAM use client-server styles, for which the terminal in the X-Window environment is the server, whereas the terminal in the DOAM model is the client.)

An approach being considered for XALS for defining ASEs is that each ASE is a complete specification of a function, together with the application protocol data units (APDUs) that support it. The APDUs are defined in one or more abstract syntax specifications within the ASE standard. The name of the specification is a parameter used when establishing a presentation connection, with each resulting transfer syntax assigned its own presentation context. Concurrent use of multiple ASEs would be accomplished by either APDU concatenation or embedding one APDU in another as user data. FTAM, CCR, VT, and ACSE fit this proposed model, but not Directory, ROSE, or RTSE. The Directory protocol, for example, is used in conjunction with ROSE to completely specify an abstract syntax--the relationship between Directory and ROSE is not one of APDU concatenation or user data embedding. Use of XALS would benefit work in RPC and other ASE areas [SC21 N 4519 1990].

Future work on XALS is expected to include the following:

- Peer-to-peer relationship (in addition to application associations) [SC21 N 4905 1990]
- Recovery model, new work item (JTC1 N 764) approved June 1990 [SC21 N 4910 1990; SC21 N 5011 1990]. [SC21 N 4106; CD text was expected in June 1991]
- Multi-level structures, new work item (JTC1 N 846) approved June 1990 [SC21 N 4909 1990].

6.2.4 Distributed Applications

Application Layer standards often define, at least partially, distributed applications. Examples are MHS, Directory, and FTAM; specifically, Directory contains a specification of a directory information tree (DIT) and its associated navigation rules. The nodes of the DIT for CCITT are envisioned to be distributed worldwide. Such standards contain elements that relate to features (and models) of distributed applications, in addition to features related to communications transfer. In this regard, these standards relate both to the ODP model and the ALS model.

The following are examples of tasks being proposed in generic work on distributed applications [IST/21: 1721 1989; SC21 N 4520 1990]:

- Model information held by distributed applications and address issues of distribution and local transparency (the ODP work has chosen to recognize five different viewpoints from which various features of a distributed application can be modelled); *Modelling for Communications Aspects of Distributed*

Applications has been accepted by JTC1 and assigned to SC21/WG6 [SC21 N 4911 1990]. CD text was expected in June 1991.

- Formalize management interactions between application processes in specific protocols in such functions as establishing relationships, distributing data, and replicating data.
- Devise global security mechanisms for use throughout the entire domain of the distributed application.
- Enable the schema for information held at an applications process to be distributed among cooperating systems.
- Address database issues such as data integrity and consistency, together with replication of data.
- Identify constraints on process decomposition and interaction types (communication among subprocesses).
- Specify distributed application support for configuration management, reconfiguration, and routing.
- Define application features to allow migration for future extensions.
- Address real-time effects associated with distribution.
- Provide for time synchronization of application processes.

However, true distributed applications have yet to be achieved since the network is not hidden. A promising tool in this area is the RPC tool (see Section 6.3.6.5), which allows applications at run-time to move from one transport, such as TCP/IP, to another such as OSI [OSN 1990c].

6.3 Standards for Network Services

This section begins with a description of the base standards that have been defined for the OSI seven-layer model. Stacks of base standards are described separately for application options, transport options, and relay options. The chapter concludes with an overview of ongoing work for developing international standardized profiles and OSI environments.

Figure 10 provides an overview of the standards applicable to network services for data communications. The layer OSI standards are connected by vertical lines to depict a wide range of stacks for application and transport options. OSI management, security, registration authorities, conformance testing, and other standards applicable to all the WAM

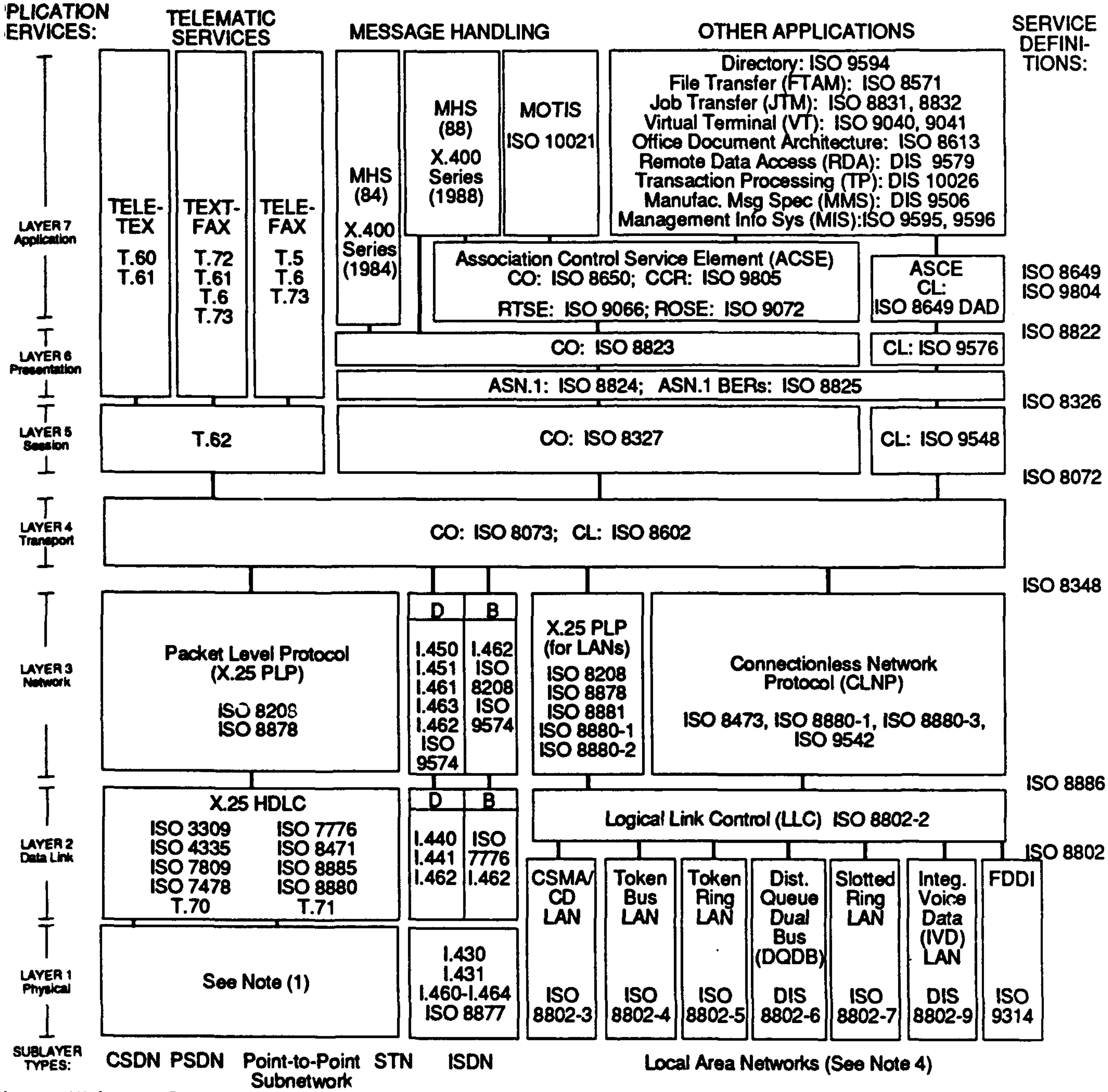
classes of services are identified and discussed in Chapter 9--these are not included in Figure 10. U.S. GOSIP is based on the standards shown in Figure 10.

Figure 10 depicts examples of possible application and transport options. The types of transfer service options are identified along the bottom of the figure. Standards and options in a layer common to several stacks are shown in blocks. For example, the Logical Link Control (LLC) in Layer 2 is common to stacks for all types of LANs shown in Figure 10. Above the LLC, the CO-mode X.25 Packet Level Protocol (PLP, ISO 8208, 8878, 8880-1, 8880-2, and 8881), and the connectionless network protocol (CLNP) apply to each of the four LAN options. The X.25 PLP (ISO 8208 and 8878) in Layer 3 and the High-Level Data Link Control (HDLC) in Layer 2 are required for the stacks for four types of circuits: Circuit Switched Data Network (CSDN), Packet Switched Data Network (PSDN), Point-to-Point Subnetwork, and Switched Telephone Network (STN).

Task Group X3S3.7 of Accredited Standards Technical Committee X3S3 - Data Communications has begun an effort to develop a standard to be used in conjunction with frame relay standards. It could be used in other cases where X.25 virtual circuit (VC) establishment and clearing procedures and other non VC-specific procedures are not needed. This standard will be a subset of Recommendation X.25 and ISO 8208 [X3 1991g].

6.3.1 OSI Base Standards

This section identifies the OSI standards that are relevant to network services for data communications. Table 2 (above) identified OSI options applicable to WAM, which are, with the possible exception of VT and JTM, all relevant to the communications services. The most useful form in which to present the specific standards that support OSI options is ordered groupings (called stacks) to show their application to specific interfaces and services. Tables 14, 15, and 16 identify stacks for application options, transport options, and relay options, respectively. The relationship among these three classes of options was described earlier in Figure 7.



Notes: (1) Layer 1 Standards are:
(a) CSDN/PSDN: ISO 2110, 2593, 4902, 4903; V.24, V.28, V.35, V.36; X.21, X.21bis, X.22, X.24, X.26, X.27,
(b) Point-to-Point Subnetwork: Predefined
(c) STN: ISO 2110, 2593, 4902, V.10 or V.11, V.20, V.24, V.27, V.31bis, V.35, V.36, V.37, V....

(2) Standards are CCITT unless designated ISO, DIS, or DP.
(3) Stacks are based on 1989 *NTIS Transition Strategy*.
(4) Each LAN standard addresses both Layer 1 and Layer 2 (Media Access Control).

Figure 10. Stacks of Standards for Application and Transport Options

The stacks are taken primarily from the 1988 recommendations of TSGCE SG9 for the *NTIS Transition Strategy* [NATO 1989]. (Appendix B provides figures that depict in more detail 4 application, 20 transport, and 11 relay functional profiles from the 1989 *NTIS Transition Strategy*.) The profile reference used in the *NTIS Transition Strategy* is given in the first column of Tables 14, 15, and 16 (the symbol "ICT" identifies intercept recommendations that have no profile number). The standards include CCITT recommendations (e.g, T.60, X.402, V.24) and ISO standards.

Of the possible sets of transport standards for LANs providing combinations of CO-mode and CL-mode transport and network services, CL transport with CO network service has not yet been included in Table 15. Standards for the case of asynchronous devices (start-stop transmission) are listed under Options in the second part of Table 15, although the relevant standards (X.28 and X.29) also control OSI layers above Layer 4.

6.3.2 MHS and MOTIS

6.3.2.1 Message Handling Standards

Table 17 summarizes the set of standards that define MHS (CCITT X.400) and the Message-Oriented Text Interchange System (MOTIS, ISO 10021) services. Efforts have been made by CCITT and ISO to converge MHS and MOTIS. The result, defined by standards released in 1988, is a substantially but not completely compatible set of new standards. [Balloting for the previous MOTIS standards (DIS 8505, DIS 8883, and DIS 9065) was suspended, and the scope of these standards has been incorporated in ISO 10021.] The relationship of the X.400-1984 (MHS-84), X.400-1988 (MHS-88), and MOTIS-1988 standards is provided in Table 17. Notice that MOTIS still has no parallel to the X.408 standards for algorithms used when converting between different types of encoded information, no parallel for the X.430 (now T.430) Teletex access protocols, and none for X.403.

Table 14. Upper-Layer Stacks of Base Standards for Application Options

NATO Profile	Application Option	Layer 5	Layer 6	Layer 7
A.1	File Transfer, Access and Management (FTAM)	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 8571 ISO 8649 ISO 8650
A.2	Teletex	T.62	T.60 T.61	T.60 T.61
A.2	Textfax	T.62	T.72, T.61 T.6, T.73	T.72, T.61 T.6, T.73
A.2	Telefax	T.62	T.5, T.6 T.73	T.5, T.6 T.73
A.3[*]	Message Handling Service (MHS-88); MOTIS	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 10021 ISO 9066 ISO 9072 ISO 8649 ISO 8650 X.403, X.408 T.330
A.4	Virtual Terminal (VT)	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 9040 ISO 9041
A.5	Transaction Processing	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	DIS 10026-1,2,3
A.6	Job Transfer and Manipulation (JTM)	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 8831 ISO 8832
A.7	Remote Data Access	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	DP 9579
A.8	Management Information System (MIS)	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 9595 ISO 9596
A.9	Directory	ISO 8327 ISO 9548	ISO 8823 ISO 9576 ISO 8824-25	ISO 9594 X.500, X.501 X.509, X.511 X.518, X.519

Source: [NATO 1988].

*Note: Transition Strategy cites MMHS for NATO Profile A.3; most currently defined MMHS requirements appear to be in MHS-1988 (analysis by TSGCEE SG9 is not yet complete).

Table 15. Lower-Layer Stacks of Base Standards for Transport Options

NATO Profile	Transport Optio	Layer 1	Layer 2	Layer 3	Layer 4
T.21	Permanent Analogue Circuit	V.24 V.35 V.36 ISO 2110.2 ISO 2593 ISO 4902.2	ISO 3309 ISO 4335 ISO 7478 ISO 7776 ISO 7809 ISO 8471 ISO 8885	ISO 8208 ISO 8878	ISO 8073 (Classes 0 & 2)
T.31	Permanent Access to PSDN: End System	X.21 ISO 4903.2	ISO 3309 ISO 4335 ISO 7478 ISO 7776 ISO 7809 ISO 8471 ISO 8885 X.25	ISO 8208 ISO 8878 X.25	ISO 8073
	PSDN		X.25	X.25	X.25
T.32	Permanent Digital Circuit	X.21,DIS 4903.2	ISO 7776	ISO 8208	ISO 8073
?	Switched Telephone Network (STN)	X.28	ISO 7776	ISO 8208	ISO 8073
T.41	Switched Digital Circuit (CSDN): (CCITT T.70 Type)	X.21	T.70 X.21	T.70 X.21	ISO 8073 (Class 0)
T.42	Switched Digital Circuit (CSDN): Call Control and Clearing Phase Data Transfer Phase	 X.21 X.21,ISO 4903.2	 X.21 ISO 7776	 X.21 ISO 8208	 N/A ISO 8073
T.61	LAN Providing CO Network Service and CO Transport Service	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/2 ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8881 ISO 8878 ISO 8208	ISO 8073
T.62	LAN Providing CL Network Service and CO Transport Service	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/2 ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8473	ISO 8073 (Class 4)
T.63	LAN Providing CL Network Service and CL Transport Service	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/2 ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8473	ISO 8602
ICT	Asynchronous Devices (Start-Stop Transmission)	X.20	X.28, X.29	X.28, X.29	X.28, X.29
ICT	Integrated Services Digital Network (ISDN): D Service (16,000 b/s)	I.430, I.431 I.460-463 ISO 8877	I.440, I.441 I.462	I.450, I.451 I.460	ISO 8073
	B Service (64,000 b/s)	I.430, I.431 I.460-463 ISO 8877	I.462	I.462 T.70	ISO 8073

Source: [NATO 1988].
Note: ICT identifies a TSSGCEE SG9 intercept recommendation that is not part of the NATO profile taxonomy.
Note: ISDN standards have been changed in the 1988 CCITT recommendations; new numbers need to be identified and incorporated here and elsewhere. *See Annex D and Annex E (Part II).*

Table 16. Stacks of Base Standards for Relay Options

NATO Profile	Relay Option	Layer 1	Layer 2	Layer 3
R.12	LAN to WAN/PSDN to LAN:			
	LAN		ISO 8802/2	ISO 8473
		ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	
	WAN/PSDN	X.21 ISO 4903	X.25 ISO 7776	X.25 ISO 8208
	Internetworking Service			ISO 8648
R.13	WAN/PSDN to WAN/PSDN	X.75	X.75	X.75
R.21	LAN to LAN:			
	LAN		ISO 8802/2	ISO 8473
		ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8208
	Internetworking Service			ISO 8648
R.22	LAN to WAN/PSDN:			
	LAN		ISO 8802/2	ISO 8881
		ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	ISO 8802/3 or 8802/4 or 8802/5 or 8802/7	
	WAN/PSDN	X.21 ISO 4903	X.25 ISO 7776	X.25 ISO 8208
	Internetworking Service			ISO 8648

Source: [NATO 1988].

Table 17. Base Standards for Message Management

LAYER	MHS CCITT X.400-1984	MHS CCITT X.400-1988	MOTIS ISO-1988
7 7	X.400 X.401	X.400[a]	ISO 10021-1
7	X.400	X.402	ISO 10021-2
7	N/A	X.403[b]	None
7	N/A	X.407	ISO 10021-3
7	X.408	X.408	None
7	X.409	X.208 X.209	ISO 8824 ISO 8824 DAD1 ISO 8825 ISO 8825 DAD1
7	X.410	X.218 X.219 X.22 X.2298	ISO 9066-1 ISO 9072-1 ISO 9066-2 ISO 9072-2
7	X.411	X.411 X.419[c]	ISO 10021-4 ISO 10021-6
7	N/A	X.413	ISO 10021-5
7	X.420	X.420	ISO 10021-7
7	X.430	T.330	None
7 (ACSE)	N/A	X.217 X.227	ISO 8649 ISO 8650
6	N/A	X.216 X.226	ISO 8822 ISO 8823

[a]1988 X.400 is double-numbered with 1988 F.400.
[b]Citation for 1988 X.403 includes three manuals.
[c]1988 X.419 and ISO 10021-6 have a wider scope than the part of 1984 X.411 and DIS 8883 that they replace.
Source: Provided by OMNICON on 8 September 1988.

MHS-88 provides new (relative to MHS-84) capabilities for message store (listing, summary, fetching, and deletion of stored messages); security services (origin authentication, secure access management, data confidentiality, data integrity, nonrepudiation, and security management); distribution lists (members, submit permission, expansion point, and owner); directory services (authentication, name resolution, data list expansion, and capability assessment); physical delivery service (basic physical rendition, ordinary mail, physical forwarding, and return of undeliverable mail); and conformance testing (methods, criteria, and notation). In addition, MHS-88 revises MHS-84 standards for naming, addressing, routing, and special access.

6.3.2.2 MHS-1984 and MHS-1988 Profiles

The standards for MHS-84 include delivery notification, disclosure of other recipients, explicit conversion (Message Transfer Service), grade of delivery selection, hold for delivery, prevention of non-delivery notification, probe, stored message alert, and stored message automatic forward.

The 1988 CCITT X.400 recommendations are supplemented by a new series of standards on the service aspects of MHS. These standards are:

- F.400 *System and Service Overview*
- F.401 *Naming and Addressing for Public Message Handling Services*
- F.410 *The Public Messaging Transfer Service*
- F.415 *Intercommunication with Public Physical Delivery Services*
- F.420 *The Public Interpersonal Messaging Service*
- F.421 *Intercommunication Between the IPM Service and the Telex Service*
- F.422 *Intercommunication Between the IPM Service and the Teletex Service.*

According to analyses conducted by WG2 of TSGCE SG9, MHS-88 is not fully backward compatible with MHS-84 (due to changes in data type formats in the P1 protocol) and, even with a gateway between systems using different versions of MHS, there are several differences [Rose 1990] that could cause interoperability problems. For example, MHS-84 is unable to use the physical delivery capability of MHS-88. In addition, MHS-88 users may not be able to communicate with Telex terminals on an MHS-84 system. Finally, MHS-84 systems will reject some addresses that may be valid for MHS-88 systems. Addressing these problems without service request rejection will require a complex gateway. The incompatibilities of the MHS-84 and MHS-88 standards could present serious interoperability issues since WAM or other ADP-supported CCISs might adopt the newer standard, but a variant of the older standard [*Standard Automated Message Interface for NATO ACCIS (STAMINA)*, described in Appendix K] has been mandated for the ACE Automated Command and Control Information System (ACCIS) that supports battlefield command and control entities at echelons above corps. Note that while the 1989 *NTIS Transition Strategy* [NATO 1989] identifies the MMHS(84) as an intercept interoperability functional profile, the following caveat is included:

It must be clearly stated that the MMHS-STANAG will be based on CCITT X.400 series version 1988, which offers a considerably enhanced functionality, including security services. Problems with backward compatibility cannot be precluded.

However, backward compatibility of MHS-88 with MHS-84 is being claimed by many technical experts [NIST 1988; NIST 1989; Manvos 1989; X.400 1989; OSN 1988]]. According to Jim White [OSN 1988], CCITT Special Rapporteur for X.400, "backwards compatibility between 1984 and 1988 P1 has been achieved." P1 is the relay protocol from one Message Transfer Agent (MTA) to another. 1988 and 1984 products implementing P1 would be able to interwork because the 1988 P1 is a superset of the 1984 P1. However, the same is not true of the P3 protocol used for submission and delivery access for a remote User Agent. Specifically, it is not possible for a 1988 UA to use the P3 protocol to communicate with a 1984 messaging system. The rules that a 1988 system shall obey when interworking with 1984 systems are defined in Annex B, *Interworking with 1984 Systems,* of CCITT X.419.

6.3.2.3 Manufacturing Message Specification (MMS)

A Manufacturing Message Specification (MMS) has been defined. MMS is the key component of the Manufacturing Automation Protocol (MAP), the OSI protocol promoted worldwide by General Motors. MMS was originally developed as Electrical Institute of America (EIA) RS-511 [INI 1987]. The MMS work in ISO is under TC184/SC5/WG1, which is responsible for communications systems in the area of industrial automation [Kirk 1990]. The MMS standard has two parts: ISO 9506-1 *(Service Definition)* and ISO 9506-2 *(Protocol Specification).* While MMS is a standard primarily used for industrial automation, it is included because its wide use may affect some military message standards. Section 6.3.8.2 discusses the time-critical communications requirements of MAP.

6.3.3 File Transfer, Access, and Management (FTAM)

6.3.3.1 FTAM Standards

FTAM defines a file service and specifies a file protocol within the Application Layer (Layer 7). The standard is concerned with identifiable bodies of information that can be treated as files, which may be stored within open systems or passed between application processes. ISO 8571 defines the basic file service for FTAM. It provides sufficient facilities to support file transfer and establishes a framework for file access and file management. This standard does not specify the interfaces to a file transfer or access

facility within the local system. An addendum may be added that reflects quality of service developments and integration. The FTAM standard currently has five parts with amendments and addenda. An additional standard describes a performance test suite. The pertinent FTAM standards are:

- ISO 8571-1, Part 1: *General Introduction*
  - AM1 Amendment 1: *Filestore Management*
  - PDAD2 Addendum 2: *Overlapped Access*
  - WDAM 3 Amendment 3: *Service Enhancement*
- ISO 8571-2, Part 2: *Virtual Filestore Definition*
  - AM1 Amendment 1: *Filestore Management*
  - PDAD2 Addendum 2: *Overlapped Access*
  - WDAM 3 Amendment 3: *Service Enhancement*
- ISO 8571-3, Part 3: *File Service Definition*
  - AM1 Amendment 1: *Filestore Management*
  - PDAD2 Addendum 2: *Overlapped Access*
  - WDAM 3 Amendment 3: *Service Enhancement*
- ISO 8571-4, Part 4: *File Protocol Specification*
  - AM1 Amendment 1: *Filestore Management*
  - PDAD2 Addendum 2: *Overlapped Access*
  - WDAM 3 Amendment 3: *Service Enhancement*
- ISO 8571-5, Part 5: *PICS Proforma* (awaiting publication)
  - WDAM1 Amendment 1: *Filestore Management*
  - WDAM2 Amendment 2: *Overlapped Access*
  - WDAM 3 Amendment 3: *Service Enhancement*
- *Conformance Test Suite for the FTAM Protocol*
  - ISO 10170-1, Part 1: *Test Suite Structure and Test Purposes,* November 1990 (IS text expected October 1991)
  - WD 10170-2, Part 2: *FTAM Abstract Test Suite* (CD expected October 1992)
  - WD 10170-3, Part 3: *ACSE Abstract Test Suite Embedded Under FTAM* (CD expected June 1993)
  - WD 10170-4, Part 4: *Presentation Abstract Test Suite Embedded Under FTAM* (CD expected June 1993)
  - WD 10170-5, Part 5: *Session Abstract Test Suite Embedded Under FTAM* (CD expected June 1993)
- *Enhancements to FTAM Security Services, JTC1 N955,* July 1990 (CDAM expected October 1992).

The current FTAM standard treats a filestore as an unstructured collection of files. Amendment 1 defines a structured filestore to allow the organization and manipulation of individual groups of files. Addendum 2 on Overlapped Access allows more efficient access to contents of a structured file. The Overlapped Access working draft specification uses the formal description language LOTOS. These extensions will support needs of the Network File Store, but harmonization with DTAM (CCITT) and DFR (SC18) will be needed. PICS proformas such as ISO 8571-5 provide a framework for specifying compliance with all the interoperability parameters for the implementation of a protocol; this concept is discussed in Section 9.4.1.

In order to cope with the wide range of possible file mechanisms, FTAM uses a virtual filestore model. In FTAM's virtual filestore model, files are structured. Each file has a set of attributes (e.g., owner information and contents type), in addition to the data association with the file. The contents type of the file defines the file structure. Currently FTAM is not easily exportable to other application services. The new work will attempt to improve efficiency by reducing the number of confirmed requests (e.g., needed for file transfer over long-haul communications), extend and simplify FTAM services to allow other applications services (e.g, TP) to easily use FTAM services (e.g., for data transfer) with minimum overhead by providing high-level services, and to provide file services for other user services, such as CCITT telematic services.

SC21/WG5 is developing a document type to enable FTAM to transfer CGM files as a structured file rather than (with current FTAM) as a transparent sequence of octets. The new work would provide access to the whole metafile, to the metafile descriptor, or to the individual pictures with an associated metafile descriptor. All three CGM encoding techniques would be supported: binary, clear text, and character text [SC 21 N4192 1989].

EWOS is developing a Remote Actions (RA) service and protocol for use with FTAM to support the ability to perform a remote action upon completion of a file operation. Examples of a remote action would be execution of a batch job that is transferred to another system via FTAM and to spool a print file to a printer after being transferred using FTAM. Both RPC and JTM could provide this support, but JTM is viewed in EWOS as too complex for simple remote actions. RA would not compete with JTM and specifically would not support such JTM services as gathering information for input to a job, spawning jobs to several systems, manipulating entries in job queues (e.g., kill a job), monitoring progress of jobs, or preparing progress reports [EWOS 1990].

The Joint European Standards Institution (CEN/CENELEC) has issued four European Standards (ENVs):

- ENV 41 204, FTAM - *Simple File Transfer*, September 1989
- ENV 41 205, *FTAM- File Management*, June 1989
- ENV 41 206, *FTAM - Positional File Transfer*, June 1989
- ENV 41 207, *FTAM- Positional File Access*, June 1989.

6.3.3.2 Options and Profiles for FTAM

Protocols and services for FTAM are specified in ISO 8571. The ISO standard (ISO 8571-2, Annex B) provides for three document types: unstructured text, sequential text, and unstructured binary. NOIW Stable Implementor's Workshop agreements have been published by NIST for four others: sequential file, random access file, indexed file, and file directory file. Six implementation profiles have been defined by the European Standards Promotion and Application Group (SPAG), which have the following corresponding profiles from the NIST OSI Implementor's Workshops:

- *Simple file transfer* (SPAG A/111, NIST T1, ENV 41 204)
- *Positional file transfer* (SPAG A/112, NIST T2), ENV 41 206)
- *Full file transfer* (SPAG A/113, NIST T3)
- *Simple file access* (SPAG A/122, NIST A1)
- *Full file access* (SPAG A/123, NIST A2)
- *Management* (SPAG A/13, NIST M1).

An International Standardized Profile (ISP) is being developed by the JTC1 Special Group on Functional Standardization (SGFS) for FTAM. There are currently six parts:

- ISP 10607-1, AFT nn - *File Transfer, Access, and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by FTAM*, 17 January 1991 [SGFS N 282] (submitted by SPAG) ISP accepted December 1990.
- ISP 10607-2, AFT nn - *File Transfer, Access, and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes*, 17 January 1991 [SGFS N 285] (submitted by SPAG) ISP accepted December 1990.
- ISP 10607-3, AFT nn - *File Transfer, Access, and Management - Part 3: AFT 11 - Simple File Transfer Service* (Unstructured), 17 January 1991 [SGFS N 286] (submitted by SPAG) ISP accepted December 1990.

- ISP 10607-4, AFT 12 - *File Transfer, Access, and Management - Part 4: AFT 12 - Positional File Transfer Service*
- ISP 10607-5, AFT 22 - *File Transfer, Access, and Management - Part 5: AFT 22 - Positional File Access Service*
- ISP 10607-6, AFT 3 - *File Transfer, Access, and Management - Part 6: Specification of ACSE, Presentation, and Session Protocols for the Use by FTAM.*

6.3.4 Directory

CCITT is developing a database application standard for logically storing directory information. The Directory is a distributed database on users, processes, and other objects, used to provide access to information that people or processes require prior to communicating. The standards are in the following X.500 Series recommendations: X.500, X.501, X.509, X.511, X.518, X.519, X.520, and X.521.

6.3.4.1 Directory Services and Models

The Directory services provide a specialized hierarchical database, called the Directory Information Tree (DIT), for OSI applications. The Directory contains information about objects and provides structured mechanisms for accessing that information. These services are intended to provide user friendly naming to permit a user to specify an object's name and then retrieve additional addressing information. The two key aspects of the OSI Directory, which distinguish it from other database and name-server work, are [OSN 1990d]:

- The Directory can be read, modified, and searched remotely via OSI protocols.
- A highly distributed database is provided by Directory System Agents (DSAs).

The following four models define the Directory services:

- The informational model describes the Directory Information Base (DIB). The DIB contains all the information to which the Directory provides access. This model is concerned only with the logical structuring of the information.
- The functional model describes interactions that take place between the various DSAs that comprise the Dictionary.
- The organizational model describes how portions of the Directory tree map onto the DSAs. This includes issues of replication and access control.

- The security model of Directory services describes the service in terms of authentication and authorization. ISO 9594-8, *OSI Directory Authentication Framework,* has now been transferred to SC21/WG1 (Security).

6.3.4.2 Directory Standards

SC21/WG4 is working on OSI directories. ISO standards for the Directory are:

- ISO 9594-1, *Overview of Concepts, Models and Services,* July 1990 [SC21 N 4701] (CCITT X.500)

  PDAM 1, *Replication, Schema and Access Control* [SC21 N 5416, 4 December 1990]

- ISO 9594-2, *Models,* July 1990 [SC21 N 4702] (CCITT X.501)

  PDAM 1, *Access Control* [SC21 N 5432, 14 November 1990]
  PDAM 2, *Schema Extensions* [SC21 N 5417, 4 December 1990]
  PDAM 3, *Replication* [SC21 N 5418, 4 December 1990]

- ISO 9594-3, *Abstract Service Definition,* July 1990 [SC21 N 4703] (CCITT X.511)

  PDAM 1, *Access Control* [SC21 N 5433, 14 November 1990]
  PDAM 2, *Replication, Schema and Enhanced Search* [SC21 N 5419, 4 December 1990]

- ISO 9594-4, *Procedures for Distributed Operations,* July 1990 [SC21 N 4704] (CCITT X.518)

  PDAM 1 *Access Control* [SC21 N 5434, 14 November 1990]
  PDAM 2: *Replication, Schema and Enhanced Search* [SC21 N 5420, 4 December 1990]

- ISO 9594-5, *Protocol Specifications,* July 1990 [SC21 N 4705] (CCITT X.519)

  PDAM 1 *Replication* [SC21 N 5421, 4 December 1990]

- ISO 9594-6, *Selected Attribute Types,* July 1990 [SC21 N 4706] (CCITT X.520)

  PDAM 1 *Schema Extensions* [SC21 N 5422, 4 December 1990]

- ISO 9594-7, *Selected Object Classes,* July 1990 [SC21 N 4707] (CCITT X.521)

  PDAM 1 *Schema Extensions* [SC21 N 5423, 4 December 1990]

- ISO 9594-8, *Authentication Framework,* July 1990 [SC21 N 4708] (CCITT X.509)

  PDAM 1 *Access Control* [SC21 N 5435, 14 November 1990].

The following standards are under development by ISO:

- CD 9594-9.2, *Replication* [SC21 N 5424, 4 December 1990]
- WD 9594-10, *Directory PICS Proforma,* July 1989 [SC21 N 4039] (CD text expected in June 1992, DIS text in June 1993, and IS text in June 1994)
- WD 9594-X, *Text Suite Structure and Test Purposes and Abstract Test Suite for the OSI Directory,* August 1990 [SC21 N 4951] (NWI not accepted)
- WD 9594-Y, *Replication and Knowledge Management,* July 1990 [SC21 N 4913] (CD text expected June 1992).

The Directory Defect Resolution Committee has also produced a *Directory Implementor's Guide* [SC21 N 5426, October 1990], which is a compilation of reported defects in the 1988 X.500 Recommendations (ISO 9594) standards and their resolutions. It is intended to be an authoritative source of information for implementors to read in conjunction with the Recommendations/Standards themselves. The Guide is in its third version.

6.3.4.3 Enhancement to Directory Standards

CCITT SG VIII and SC21/WG4 are collaborating on enhancements to the Directory. Two areas being addressed are the Extended Information Model and Extended Search. The Extended Information Model work covers the generic way in which information is viewed in the Directory, from the viewpoint of both users and system administrators. The Extended Search work covers how extensions to the current searching mechanisms might be provided to offer a better service to the users of the Directory [IST/21: 2041 1990].

Extensions have been proposed to the DIT Structure Rule used to control the positioning of entries in the DIT based on the values of the Object Class attributes. The extensions would allow the subschema administrator to specify, within the portions of the DIB to which the subschema is applicable, criteria that allow the existence of entries based not only on the Object Class attributes of child entries and their parent entries, but also on the Object Class attributes of their other ancestor entries [SC21 N 4804 1990].

The concept of extensible matching rules is being developed in CCITT SG VII and SC21/WG4 for use in Directory and Enhanced Search. Capabilities such as approximate matching, diacritics-ignore matching, regular expressions, and word-sensitive searching are supported [SC21 N 4623 1990].

Work on a replication abstract service for the Directory is based on MHS abstract service definition conventions (ISO 10021-3). An underlying assumption is that the replication abstract service will be realized by means of ASEs. Data transfer systems, external to the DSA, may be needed to carry shadow updates. Replication operations are Request Shadow, Request Update, Refresh Shadow, and Terminate Shadow [SC21 N 4806 1990].

EDI users have requirements for use of Directory in which the naming structure would not necessarily be country oriented but would enable the current trading practices that use certain trading partner names [SC21 N 4799 1990].

CCITT and SC21 are considering the following features and facilities for joint work on Directory [SC21 N 4801 1990]:

- Inverted directories for Telex and Teletex services
- Additional information with or after the result of a query
- Query cost information
- Information about services, service instructions, tariffs, etc., in standardized formats, taking into account additional attributes
- Additional service controls
- Full functionality of access control mechanisms
- Ability of the user to indicate the desire not to receive partial results when service control maximum parameters are exceeded
- Return of multiple responses in groups of any specified number
- Administrative procedures for authentication
- Standardized error service messages
- Shadowing (controlled replication) of Directory information
- Geographical extension
- Consequences of distributed Directory services.

In October 1990, the United States offered a working document [SC21 N 5351] on Time Stamps for consideration by the collaborative meeting of CCITT and SC21/WG4 in Ottawa. It contends that time stamps are likely to be useful in the administration of directory user information, knowledge information, and replication information. With respect to time stamps in the Directory Information Model, it suggests two modifications: (1) to include (optionally) the identity of the principal responsible for the last modification of an entry and (2) to correct the redundancy that has occurred in the working documentation: the entry time stamp is documented in both the schema and the replication document in slightly different ways. Moreover, knowledge attributes may be multivalued and time stamp information for each value is likely to be of interest. Therefore, in order to time stamp knowledge information, the definition of knowledge itself must be modified. The document suggests how to do this. Finally, it suggests that there are two forms of replication in the directory replication model--caching and shadowing--and that each form should have its own form of time stamp.

6.3.4.4 Options and Example Interoperability Parameters for Directory

Two international groups are working on functional standards (profiles) for the Directory. The issues being addressed by the NIST OSI Implementor's Workshop Directory Services SIG and the EWOS/ETSI Directory Expert Group indicate options within the Directory standard and areas where baseline standards may be exceeded to address practical implementation problems. Examples of the issues and options are [IST/21: 1868 1989]:

- Classification of minimum schema capabilities.
- Classification of baseline structure rules--mandates the capability to access a standard Directory tree (which may be extended to a wide variety of entries).
- Definition of maximum APDU size--eases design of high-performance DSAs (e.g., to ensure the Directory can respond in seconds) and eases network problems in providing quality of service.
- Pragmatic constraints on filters--protects the Directory from pathological conditions and potentially simplifies design.
- Holes in distributed operation definitions--there are many undefined aspects for distributed operations (e.g., how to handle errors).

- Constraints on alphabets--Directory uses T.61 strings. Directory profiles are addressing rejection of strings that contain non-T.61 characters and restrictions on permissible characters (e.g., escape characters).
- Constraints on integer values--defines a minimum size integer that must be supported.
- Classification of authentication--mandate use of simple uncorroborated authentication that supports external authentication within a closed domain.
- Augmentation of attribute syntax rules--augments the standards material with practical rules.
- ASN.1 rules--mandates support of ASN.1 identifier tags that are three octets in length (and no longer) and requires constructed string elements not to be nested more than one deep.
- Strong authentication algorithms--proposing alternatives to the use of RSA™ (a licensed product) for digital signatures.

6.3.5 Job Transfer and Manipulation (JTM)

JTM (ISO 8831 and 8832) was originally designed for remote off-line (batch) processing. It uses a processing model based on movement of entities called "documents" and the exchange of these entities with users. Exchanges are specified in work specifications that include a data structure and an envelope carrying the document. In Basic Class JTM a single document can be sent to a processing element. In Full JTM (ISO 8832/DAM1, Full Class Protocol) multiple documents and multiple processing steps would be permitted.[20] Capabilities of JTM are being included in standards for FTAM (e.g., RA) and the ASEs (e.g., RPC) [SC21 N 4356 1990].

The United States stated in ISO in March 1990 that there are no U.S. user requirements nor any organization in the United States willing to provide resources for JTM standards [SC21 N 4641 1990]. AFNOR has similarly found little interest in industry for JTM and recommended further work be suspended [SC21 N 4603 1990]. Nevertheless, the reassessment report for JTM Full Class [SC21 N 4679 Revised] recommended completion of the International Standard texts, given the advanced state of the work. The recommendation was approved by SC21 in June 1990 [IST/21: 2160 1990].

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[20] ISO 8832/AM 1, *Extension to Specification of the Full Protocol*, 28 May 1990 [SC21 N 5224]. Merged text of ISO 8832 1989 with revised text of AM1 is provided in SC21 N 5225 dated 28 May 1990.

SC21 also agreed in June 1990 to prepare a formal tutorial/usage guide that includes JTM scenarios and shows how JTM fits with other ASEs [SC21 N 4679].

6.3.6 Application Service Elements

The services performed in the Application Layer of the OSI model can be thought of as application processes whose communication aspects are represented by application entities. The OSI Application Layer structure permits an application process to have multiple communication aspects and, hence, multiple application entities.

An application entity is a collection of one or more ASEs. Each of the peer application entities have identical ASEs. Additionally, each ASE talks only with its peer in the remote application entity. The remainder of this section discusses the ASEs:

- Association Control Service Element (ACSE), which provides association control and manages connections between application entities
- Commitment, Concurrency, and Recovery (CCR), which provides fault tolerance and manages error indication and recovery
- Reliable Transfer Service Element (RTSE), which manages bulk data transfers
- Remote Operations Service Element (ROSE), which manages request/reply interactions
- Remote Call Procedure (RPC).

A typical application process might have a user element orchestrating the application entities' actions. This user element could use RTSE services to manage associations via ACSE services and could use the ROSE, which invokes RTSE services, to transfer data through the use of the presentation service.

6.3.6.1 Association Control Service Element (ACSE)

The ACSE provides service to both user elements and to specific application service elements. The purpose of this service is to support the establishment, maintenance, and termination of application associations. Because the ACSE manages the association of application entities, all OSI applications contain an ACSE. The services provided by ACSE are:

- ASSOCIATE, which sets up an application association
- RELEASE, which releases an association in an orderly fashion

- ABORT, which terminates application association simultaneously with the underlying presentation and session connections.

The ISO definition of the service is technically aligned with the 1988 CCITT recommendation on the ACSE service. The differences between the ISO definition and the CCITT definition are quite small and are not expected to affect interoperability between implementations written against either document [Rose 1990]. There are four relevant ISO standards:

- ISO 8649, *Service Definition for the Association Control Service Element (ACSE)*
- ISO 8650, *Protocol Specification for the Association Control Service Element (ACSE)*
- DIS 8650-2, *ACSE, Part 2: PICS Proforma* (Document will not be balloted until session PICS is at DIS Status)
- ISO 10035, *Connectionless ACSE Protocol Specification*
- DIS 10169-1, *Conformance Test Suite for the ACSE Protocol, Part 1: Test Suite Structure and Test Purposes* (ballot closed October 1990, and editing meeting held January 1991; proposed progression to IS is not defined).

In addition, ISO 8650 and 8649 have three draft addenda: *Authentication, Connectionless ACSE Service,* and *A-Context Management Service.* Further, ISO 8650 has a fourth proposed addenda on *Application Entity Titles.* WD 10035-2 is the *PICS Proforma for Connectionless ACSE Protocol.*

A discussion paper [SC21 N 5835] on association pools as an extension of ACSE appeared in April 1991.

6.3.6.2 Commitment, Concurrency, and Recovery (CCR)

The CCR service and protocol standards are used to supply a more fault tolerant association than is possible with ACSE. The ACSE has two basic flaws [Stallings 1987]:

- A system crash leaves ambiguous results.
- A lack of coordination of multiple systems could produce inconsistent results.

These flaws are resolved in CCR by adding the concept of commitment. The master asks the subordinate for a commitment to perform a task (request) before the call for the execution of the task (commitment) is made. This allows for a record to be kept by

both the master and the subordinate as to the status of the task. Use of CCR can have an adverse performance impact.

Recovery is the process of determining the status of a task after an application or communication failure. The CCR service provides partial support for recovery; however, the actual recovery process is specific to the application.

Concurrency is a concept that is necessitated by the concept of commitment. Once an application entity has offered to commit, conflicting requests cannot be made against the application until the commitment is fulfilled. Concurrency is the mechanism by which committed resources are "frozen" until the committed application is completed.

There are two standards relating to CCR, and each has three draft addenda: *Enhancements, Session Mapping Changes,* and *Restart.* The ISO standards are:

- ISO 9804, *Service Definition for the Commitment, Concurrency, and Recovery Service Element*
- ISO 9805, *Protocol Specification for the Commitment, Concurrency, and Recovery Service Element.*
- CD 9805-2, *CCR, Part 2: PICS Proforma,* 28 March 1991 [SC21 N 5797].

In January 1990, a *CCR Conformance Test Suite* was proposed as a new work item [SC21 N 4279]. Another new work item [SC21 N 6126] has been proposed to write a formal description of the CCR service and protocol using LOTOS. PDTR text is expected May 1992, DTR June 1993, and TR June 1994.

6.3.6.3 Reliable Transfer Service Element (RTSE)

RTSE provides a service of reliably moving arbitrarily large objects from one application entity to another. The RTSE accomplishes this service by dealing with ASN.1 data types rather than a string of octets and by abstracting the complexity of the underlying service session into an easily usable service.

When an application context contains an RTSE, it is the sole user of ACSE services and the presentation service. The RTSE is used to signal to application elements that a transfer has been completed successfully. The ISO standard for RTSE comes in two parts:

- ISO 9066-1, *Reliable Transfer,* Part 1: *Model and Service Definition*
- ISO 9066-2, *Reliable Transfer,* Part 2: *Protocol Specification.*

6.3.6.4 Remote Operations Service Element (ROSE)

Remote operations are a popular technique for building distributed applications. The ROSE manages operations for application entities via a mechanism that is analogous to services performed by CCR for data transfer. In its most primitive form, an operation is a simple request/reply interaction. The request, or invocation, consists of:

- An operation number--a unique identifier for the operation to be performed
- An arbitrarily complex argument--the "input" for the operation
- An invocation identifier--a unique identifier for a particular invocation
- A linked invocation identifier--an indication that this operation is being invoked as a part of the processing of another invocation.

An invocation can have one of three results:

- A result--an invocation identifier corresponding to the operation that succeeded and an arbitrarily complex result
- An error--an invocation identifier corresponding to the operation that failed, an error number uniquely identifying the error that occurred, and an arbitrarily complex parameter that provides clarifying information
- A rejection--an invocation identifier corresponding to the operation that was performed and a reason that describes the rejection that occurred.

The standards that apply to the ROSE are:

- ISO 9072-1, *Remote Operations,* Part 1: *Model, Notation, and Service Definition*
- ISO 9072-2, *Remote Operations,* Part 2: *Protocol Specification.*

ROSE is a set of communications facilities to distributed applications. ROSE was derived from the Remote Operations (RO) service defined in CCITT MHS-84. The standard (ISO 9072) also provides a notation for defining them (an extension of ASN.1). Remote operations service is asynchronous, so a client need not wait for a response before invoking another operation. ISO 9072 defines the structure of remote operations and the abstract services and protocol to support them. The services are generic in that their effect on the remote object is defined by their users.

The basic interaction with a remote object is an operation that is similar to a procedure call in a programming language. An operation is invoked on a target object, to which the operation argument is passed. Operations have one of two possible structures, and invocations have two possible outcomes. Some operations return either a Result,

when they are executed successfully, or an Error; other operations produce only a response (Error) if the operation fails.

In July 1991, a new work item [SC21 N 6151] was proposed to begin extensions to ROSE.

6.3.6.5 Remote Procedure Call (RPC)

The ECMA standard for RPC is ECMA 127. As defined in ECMA 127, an RPC is a communication service to transfer procedure calls to a remote server and return results, errors, or associated call backs. One of the central notions of RPC is that of a stub. A stub builds protocol information for RPCs (marshalling) and translates protocol information to server procedure calls (unmarshalling). ECMA 127 defines an Interface Definition Notation (IDN) to facilitate the transfer of data across an interface. The IDN supports a union of programming language-specific data types such as pointers, arrays, and records, and primitive data types such as integers and bit strings. ECMA 127 limits the number of outstanding procedure calls to one per association, in order to prevent livelock situations and preserve fairness; it is unclear if this is the most efficient solution to the livelock problem. SC21/WG6 proposes to address RPC using an IDN that is based on abstract data types rather than on a union of programming language-specific data types.

Text for DIS 10148, *Basic Remote Procedure Call (RPC) Using OSI Remote Operations* [SC21 N 3463], was based on ECMA 127 and submitted in 1989 on a fast-track ballot, which failed. DIS 10148 was withdrawn, and a September 1989 proposal for a new work item was accepted by JTC1 in May 1990 [SC21 N 4027 1990]. RPC is now in its third working draft [SC21 N 6111, 25 June 1991] and WG6 has requested authorization to progress it to CD status.

The current working draft for RPC proposes an engineering model based on the Extended Application Layer Structure (XALS) (see Section 6.2.3.3). ECMA believes the XALS is not intended to cover issues that the RPC must describe and therefore it is not appropriate to use that model for this purpose [SC21 N 5593 1990].

Some of the work being undertaken in ISO with respect to RPC includes the following:

- *Nature of the OSI RPC Service Boundary and Service Provider* [SC21 N 5586, 7 January 1991]
- *Working Definitions for Client and Server* [SC21 N 5590, 7 January 1991]

- *Call for Comment on OSI RPC IDN* [SC21 N 5588, 7 January 1991]

The aim of the current work in ISO on RPC is to provide a mechanism for writing distributed applications that are both syntactically and semantically similar to a local procedure call.[21] The scope of RPC includes a language-independent IDN for specifying interfaces between components of distributed applications. The RPC protocol for a particular interface definition is derived from the IDN.

RPC is closely related to two projects in SC22: Common Language Independent Data Types (CLID) and Common Language Independent Procedure Call Mechanism (CLIP or CLIPCM) (see also Section 8.3.1). At a recent SC22 WG11 meeting, it was agreed there is no overlap between the CLI projects and RPC. However, there should be cross references between the standards. The CLI projects identified below are giving an abstract definition of datatypes and procedure call mechanism, while RPC is a concrete definition that extends the procedure calls to the distributed environment [SC21 N 5583 1991]:

- The aim of CLID is to define a set of datatypes, independent of any particular programming language specification or implementation. The set should be rich enough so that all common datatypes in standard programming languages and service packages can be mapped onto some datatype in the set. Hence, the CLID project of SC22/WG11 is producing an abstract definition of the set of datatypes in terms of the values a datatype can take and some of the operations that are valid on the datatype. The ISO RPC standard will define the set of datatypes it supports, including the presentation of values of these datatypes when exchanged in parameters of a remote procedure call.
- The aim of CLIP is to define a generic model for procedure call semantics and therefore is an abstract definition of a procedure call mechanism. ISO RPC aims to extend the semantics of a local procedure call in a distributed environment and, in particular, that RPC be semantically and syntactically similar to a local procedure call.

It is not at all clear whether remote operations (ISO 9072) can be used to satisfy RPC requirements or whether collaborative work with CCITT will be conducted for RPC [SC21 N 4926 1990]. SC21/WG6 has identified requirements for RPC and IDN [SC21 N 4928 1990] and has begun coordination of these requirements with SC22/WG11 and CCITT SG VII.

[21] The ISO approach to RPC could be a problem for Ada. This issue needs to be addressed by the WAM Architecture.

ASN.1 may not be adequate as a basis for the IDN, even if extended for this purpose. Some requirements for the IDN identified in SC21/WG6 are [SC21 N 4767 1990]:

- Be user friendly in the sense that an applications programmer can translate from the IDN to the programming language of choice in a straightforward, approximately one-to-one manner
- Be useable to automatically generate language-specific interfaces that support procedure calls using the RPC service
- Be useable to automatically generate the programming language-specific procedure declarations that correspond to the procedures in an IDN for use by a server.

There would appear to be some danger of duplication of effort--and possibly even rival standards--unless RPC is brought together, in some manner, with ROSE [OSN 1990e]. For example, ROSE has already standardized an IDN, called RO-notation, that uses ASN.1 as a language-independent way of describing the data types of the parameters. ROSE is already used widely, and a program of enhancements to allow it to meet additional needs is underway. However, ROSE is not even mentioned in the new RPC work item proposal.

Two RPC implementations currently exist: Sun RCP and OSF RPC. The two are not mutually exclusive and the key issue for the user is agreement on the application program interface so the user does not have to worry about differences in various RPCs. This requires a standardized interface definition language such as the Network Interface Definition Language (NIDL), which was developed by Apollo and is being enhanced by Digital and is the basis of an ANSI recommendation to ISO [OSN 1990g].

6.3.7 Abstract Syntax and Basic Encoding Rules

6.3.7.1 Abstract Syntax Notation One (ASN.1)

At present, ASN.1 is the only abstract syntax language that exists in OSI. Abstract syntax languages describe data types in a machine-independent manner, thus freeing data representation from machine restrictions. For example, a protocol specifying that a data type is an integer need not concern itself with the number of bits required for the internal machine-dependent representation of this data type.

ASN.1 has a rich syntax for describing data types and provides a macro facility for extending its grammar. According to Rose [Rose 1990],

> ASN.1 is destined to become the network programming language of the 90s, just as the C programming language is largely seen as having been the systems programming language of the 80s.

The pertinent specifications for ASN.1 are ISO 8824, ISO 8824/DAD1 (incorporated into ISO 8824), ISO 8824/WDAM2, and recommendation X.208 from CCITT. The ISO specifications are compatible with those of CCITT, but include a few extensions [Stallings 1987].

A revised ASN.1 standard will make the current ISO 8824 into Part 1 of a five-part standard whose parts are as follows [SC21 N 5618 1991]:

- Part 1: *General* [SC21 N 5618, 5 February 1991]
- Part 2: *Information Object Specification* [SC21 N 5619, 5 February 1991]
- Part 3: *Constraint Specification* [SC21 N 5620, 5 February 1991]
- Part 4: *Parameterisation of ASN.1 Specifications* [SC21 N 5621, 5 February 1991]
- Part 5: *Character Sets* [SC21 N 5622, 5 February 1991].

The Framework for the Support of Distributed Applications (DAF), a new activity established by CCITT SG VII to standardize common aspects of distributed applications, has been working for various enhancements to ASN.1. There are presently five working documents for possible extensions to ASN.1 in the 1992 time frame. The areas covered by these documents are [OSN 1990f]:

- Provide a firmer framework for the specification of table types and functions
- Improve current definitions of character strings
- Provide new encoding rules, Packed Encoding Rules (PER), Confidential Encoding Rules (CER), and Distinguished Encoding Rules (DER), to supplement or replace the current Basic Encoding Rules (BER)
- Improve machine processability
- Provide miscellaneous enhancements.

In July 1991, a new work item [SC21 N 6136] proposal for light weight encoding rules for ASN.1 was recommended for ballot.

A new standard, ASC·X3.208, *Transfer Syntax Description Notation*, is currently out for review by Accredited Standards Committee X3T2. It defines a notation for describing the structures of data volumes, files, records, and fields to facilitate the moving of data files between computer systems. While it provides a generalized syntax for describing the data records, it does not restrict or define their contents. It was originally developed as an internal standard by the Consultative Committee on Space Data Systems (CCSDS) to handle the transmission of space data [Freeman 1991].

6.3.7.2 Basic Encoding Rules (BER)

The mechanism that translates the abstract representation of data to its physical characteristics, either for machine storage or for transmittal, is called transfer syntax. The transfer syntax in OSI corresponding to the abstract syntax ASN.1 is contained in *Basic Encoding Rules*, ISO 8825. The relevant standards for BER are ISO 8825, ISO 8825/DAD1, ISO 8825/AD2, and CCITT X.209. Again, the ISO and the CCITT specifications are compatible.

Additional sets of encoding rules are being incorporated into ISO/IEC 8825 by making the current standard Part 1 and developing a revised ISO/IEC 8825, *Specification of Encoding Rules for Abstract Syntax Notation One (ASN.1)*, into a multi-part standard as follows:

- Part 1: *Basic Encoding Rules* [SC21 N 6295, 8 July 1991]
- Part 2: *Packed Encoding Rules* [SC21 N 6292, 8 July 1991]
- Part 3: *Distinguished Encoding Rules* [SC21 N 6293, 8 July 1991]
- Part 4: Test Suite Structure and Test Purposes for ASN.1 Encodings.

Parts 2 and 3 have reached CD status.

The BER use a "TLV" approach to mapping between abstract and physical data: each data type is encoded as a Tag, a Length, and a Value. The tag field corresponds to the label defined by the data type's abstract syntax, the length field normally indicates how many octets are used for the encoding of the value portion of the data type, and, finally, the value of the data type is encoded.

FIPS 121, *Videotext/Teletext Presentation Level Protocol Syntax*, adopts ANS X3.110-1983 (with the same title) as the specific data syntax to be used at the presentation layer (and some specific semantics for the application layer) for videotext and teletext applications. It is based on the American National Standard Code for Information

Interchange (ASCII) and its extensions. FIPS 121 provides formats, rules, and procedures for the encoding of alphanumeric text and pictorial information to be used with broadcast television videotext service.

CCITT recommendations F.200, S.60, S.61, S.62, and S.70 define the service, the terminal equipment, character repertoire, control procedures, and supporting transport services for Teletex, CCITT X.430 Recommendation (Red Book 1984) describes the access protocol for Teletex Terminals.

6.3.8 Other Standards

6.3.8.1 U.S. DoD Standards for Internetting Networks

The U.S. military has developed and widely implemented (e.g., in the Defense Data Network) unique protocols for Layers 3 and 4 that are not OSI conformant. These protocols will serve as a costandard for the U.S. DoD until transition to OSI is complete. These protocols are identified since they will be implemented in the transition strategy for tactical data systems to be fielded in the 1990s by the U.S. Army [Army 1989]. Details are provided in Appendix K. A connection-oriented transport service (COTS) is provided by the Transmission Control Protocol (TCP), which provides end-to-end reliability, and a connectionless-mode network service is provided by the Internet Protocol (IP). The IP provides connectivity over diverse network technologies.

Historically, TCP/IP arose to meet the need for reliable transmission of information over media that did not guarantee reliable, error-free delivery of information (e.g. Ethernet, Packet Radio, and Satellite). The Defense Advanced Research Projects Agency (DARPA) sponsored research into survivable multi-media packet networking in order to improve the only then-existing network, ARPANET. This research resulted in the U.S. DoD sponsored Internet suite of protocols.

TCP/IP corresponds to Layers 3-4 of the OSI model. In terms of network service, the closest comparison is between the connectionless network service (CLNS) and the service offered by the IP. The services offered by the the OSI CO-mode TP4 and the TCP are similar, however, three major differences exist:

(1) The TCP service is stream-oriented, whereas the OSI transport service is packet-oriented.

(2) The TCP service offers a graceful release, whereas the OSI offers this release in the session service.

(3) The TCP has an urgent data facility, whereas the OSI has an expedited data service.

The major emphasis of the Internet suite is on the connection of diverse network technologies (Layers 1-4). In addition, several applications for use in the Internet suite are available (see Appendix H; for a more complete listing see [Reynolds 1987]):

- Simple Mail Transfer Protocol (SMTP)
- File Transfer Protocol (FTP)
- TELNET
- Domain Name System (DNS).

These services are the analogs of MHS, FTAM, VT, and Directory, respectively. All of the Internet application protocols are rather simple. They offer a basic level of service and have a very narrow scope. The OSI applications are, in general, functionally more capable than the corresponding applications in the Internet suit [Rose 1990]. In fact, the U.S. Government, as well as manufacturers and users, endorse OSI rules at the upper layers while preserving the established TCP/IP networks for the transport of information [OSN 1990h]. Observers at the INTEROP 90 Conference and Exhibition held in San Jose, California, in October 1990 noted a shift away from pure TCP/IP topics in contrast to the previous year where strongly divided feelings about the merits of OSI versus TCP/IP were revealed [OSN 1990g].

The technical body that oversees the development of the Internet suite of protocols is termed the Internet Activity Board (IAB). The IAB is composed of senior researchers, the majority of whom are the designers and original implementors of the Internet suite. Any member of the Internet community can design, document, implement, and test a protocol for use in the Internet suite. The IAB requires that protocols be documented in the Request for Comments (RFCs) series.

There are four RFCs that define the status of documents in the RFC series. The first is the *Assigned Numbers* [Reynolds 1987], which lists the assigned values used for the parameters in the Internet suite of protocols. The second is *Official Protocols*, which lists all official protocols. The third is *Gateway Requirements*, which lists all protocols and practices that relate to network nodes. And the fourth is *Host Requirements*, which lists all protocols and practices that relate to host nodes. These RFCs are periodically updated, with the most recent document always taking precedence.

6.3.8.2 Time Synchronization

CCITT SG VII(Q19) has begun work on a time synchronization service (TSS). The work is based on the U.S. DoD RFC-1119, *Network Time Protocol (NTP)*, currently being used by the Internet community (see Section 6.3.8.1). The TSS time standard is based on the Coordinated Universal Time (UTC), determined by the Bureau International de l'Heure (BIH) from astronomical observations provided by the U.S. Naval Observatory and other observatories.[22]

The TSS can be used in distributed systems in several ways: to measure elapsed time, to preserve the order of events, and to coordinate activities of a set of processes. The elements of the TSS model are the following:

- Local clock--an oscillator that, once set with a time value, attempts to maintain a local estimate of global time
- Time user agent (TUA)--the user of the TSS
- Time synchronization agent (TSA)--the provider of the service.

Each TUA interacts with a set of TSAs to obtain information, from this information to determine the best estimate of global time, and to set the local clock to this value. The TUA may adjust the frequency of the local clock to compensate for drift in the hardware. Synchronization of clocks is by continuous distribution of time--TUAs build up information based on samples of a number of servers for the delay characteristics of the communication path between itself and each of the TSAs.

Time is distributed through the system via a hierarchical set of TSAs. Stratum 1 TSAs, at the top of the hierarchy, have local clocks that are set by external means from the most accurate sources available. These means could include radio receivers and such satellite devices as the Global Positioning System. Clocks that have been set by TUAs that have obtained time information directly from Stratum 1 TSAs are said to be at Stratum 2. At each level of the hierarchy, except the top and bottom, each TUA may have an associated TSA that can be used to distribute time information in the local clock to TUAs at the next lower level of the stratum. It is expected that there will be a number of Stratum 1 TSAs, some being provided as public services. Each site using LANs would have two or more Stratum 2 TSAs, and each LAN segment could have two or more Stratum 3 TSAs.

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22 Discussion on time synchronization was taken from SC21 N 4565, *Liaison Statement to SC21/WG4/WG7 on Time Synchronization*, CCITT SG VII, March 1990.

Individual end systems might not need to have clocks at much more than Stratum 4 [SC21 N 4565 1990].

A task force has been set up under ISO/TC184/SC5/WG2 to look at the requirements for a time-critical communications architecture (TCCA) because the network architectures set up so far are primarily intended for general traffic and are not always capable of providing adequate performance and resilience for time-critical communications, especially where time-critical and non-time-critical traffic coexist. In particular in many CIM and control installations there appears to be a requirement for an intermediate network, between general enterprise-wide networks (e.g., MAP) and field-bus-type networks. This intermediate network would carry both bulk data transfers and time-critical messages, and be able to operate over considerable distances and in hostile environments. A liaison between TC 184/SC 5/WG 2 and SC 21/WG 4, OSI Management [SC21 N 5602 1991]. ANSI X3.102, *Data Communication Systems and Services User Oriented Performance Parameters*, 1983, Revised 1990, is being used as a basis for the effort. A key requirement of a TCCA is a set of services aligned with ISO/IEC, MMS (see Section 6.3.2.3). One aspect of Time-Critical Communications Systems (TCCS) is Time Synchronization.

6.3.8.3 ISDN

ISDN is the result of the current evolution of the networks and services available from the various PTTs (Postal, Telegraph, and Telephone). The original telephone or telegraph networks (PSTNs, Public Switched Telephone Networks) were based on analog equipment. In recent years, analog equipment has been replaced with digital equipment. This has lead to the replacement of the analog PSTN with the digital IDN (Integrated Digital Network). The IDN incorporates the latest in digital switching and transmission. The extension of the IDN to provide additional user services has resulted in the ISDN.

The ISDN makes an all digital interface available to the network subscriber. This system features a high data or bit rate and digital transmission and switching. Digital switching provides a fast connect or call setup time for voice and data communications. The networks an ISDN node can connect to include packet based and circuit based networks. The networks can be switched or nonswitched. The ISDN provides a digital interface to the user. This allows the user to 'directly' connect digital devices to the network.

The protocols, services, and interfaces to an ISDN network are defined or specified in the CCITT I series recommendations (see end of Appendix E). For example, the CCITT

I.430 Recommendation specifies the physical interface to an ISDN network. It describes the bit, octet, and channel synchronization, as well as the D channel and access control. Recommendation CCITT I.440 describes the data link logical connection via the D channel. This includes the ability to transfer a packet via the D channel. The protocol used on the D channel is LAP D. LAP D is based on HDLC. The CCITT Recommendation also indicates how to establish and clear a call through a circuit switched or packet switched network. CCITT I.440 and CCITT I.441 collectively provide the service and protocol definitions and specifications for an ISDN network.

Recommendations CCITT I.450 and CCITT I.451 describe how to establish a network connection in a circuit or packet switched network. They describe the protocols for the transfer of a data packet or datagram over a connectionless network. They also describe how to perform the same task using a virtual circuit in a connection oriented network.

6.3.8.4 BISDN

BISDN or B-ISDN refers to Broadband ISDN or Broadband Integrated Services Digital Networks. ISDN concepts include broadband. The terminology BISDN exists only to focus attention on the broadband aspects of ISDN. The ISDN network can handle audio, video, and data communications. The ISDN or BISDN provides a wide range of services through flexible user-network interfaces over a limited number of connection types. BISDN can include a switched or nonswitched network connection which operates in a circuit or packet mode network.

The BISDN can offer different forms of applications and communications capabilities. The communications and applications could support distribution oriented services and/or interactive services. These services include: conversational, messaging, retrieval services, and distribution services with and without individual presentation control. Conversational services are those services which provide bidirectional (although unidirectional could be included) dialogue communications. These services could include video surveillance, videotelephony, video teleconference, and high speed data communications.

Message services are the 'typical' mail functions extended to films or moving pictures, high resolution images, and audio information. These services allow a user to create, edit, process, convert, store, and forward messages. This service allows end users to communicate with each other.

Retrieval services allows an end user to retrieve information from a 'central' location or archive site. The information could be film, high resolution image, or audio information. The information is retrieved on demand. The archive site only delivers requested information.

Distribution services can exist with or without individual presentation control. Distribution services without individual presentation control include broadcast services for television. A television viewer can select a channel, but has no control over the presentation. The start and finish of the presentation is under the control of the distribution service. A distribution service with individual presentation control broadcasts in a cyclic manner. Upon user selection, the user receives the presentation from the its beginning.

Some examples of broadband services could include: video telephony, video conference, high definition television, and videotext.

The types of services mentioned can require substantial amounts of network capacity. In addition to the ISDN B, H0, and H1 channels, this service must support the H2 and H4 channels. As with ISDN, all channels are multiples of 64 kbps. The H21 channel is 32,768 kbps and the H22 channel could have a capacity up to 45 Mbps. The H4 channel could have a rate as high as 138.240 Mbps. The broadband user interface will provide ISDN and broadband services. The user interface standard bit rates will be approximately 150 Mbps and 600 Mbps.

6.3.8.5 Fiber Distributed Digital Interface

The Fiber Distributed Digital Interface (FDDI) is a 100-Mbps LAN based on a fiber optic token ring protocol. As a standard, FDDI is still under development, but is planned for inclusion in the U.S. GOSIP Version 3. The FDDI standards are:

- ISO 9314 - 1, FDDI, [ANSI X3.148-1988] Part 1: *Physical Layer Protocol,* April 15, 1989
- ISO 9314-2, FDDI, Part 2: *Media Access Control (MAC),* May 1, 1989, [ANSI X3.139-1986]
- ISO 9314-3, FDDI, Part 3: *Physical Layer Medium Dependent (PMD),* August 1, 1990 [ANSI X3.166-1989]
- CD 9314-4, FDDI, Part 4: *Single-Mode Fiber/Physical Layer Medium Dependent* [ANSI X3.184-199X]
- CD 9314-5, FDDI, Part 5: *Hybrid Ring Control (FDDI-II),* 24 May 1990 [ANSI X3.186-199X]

- DP 9314-6, FDDI, Part 6: *Station Management (SMT) Standard* [ASC X359.5 Project 503-D].

ASC X3T9.5 has proposed a project to define a new family of standards, FDDI Follow-On LAN (FFOL). The general requirements for FFOL include:

- The ability to provide a backbone for multiple FDDI networks
- The ability to provide efficient interconnections to wide area networks (e.g., B-ISDN)
- The ability to support for a wide variety of "integrated" services such as data, graphics, video, and audio
- An initial data rate less then 1.25 Gbps
- A data rate matched to SDH
- The ability to use existing FDDI cable plant, where feasible.

The target date for completion of the basic FFOL standards is December 1995. The estimated life of the FFOL family of standards is 10 to 15 years.

Another fiber-based system, the Synchronous Data Hierarchy (SDH), (CCITT G.707, G.708, and G.709) also provides support for communication in the 100 to 600 Mbp range.

6.4 Profiles of OSI Standards

The following sections provide examples of the profiles of standards being considered for migration toward open information system environments.

6.4.1 Regional Workshops Developing OSI Profiles

Three regional international workshops have been established to promote OSI. These are the EWOS, POSI--the Asia/Oceania Workshop (AOW), and, for North America, the NIST OSI Implementor's Workshop (NOIW). A Regional Workshop Coordinating Committee has also been established to promote dialog and harmonization among the regional workshops. The goal of the workshops is to define standards profiles that will ensure interoperability of products from different vendors. As indicated in Section 6.4.3, the *Stable Implementation Agreements* [NIST 1988; NIST 1990b] from the NOIW form the basis of U.S. GOSIP. A companion document, *Continuing Agreements* [NIST 1989; NIST 1990c], provides the basis for enhancements and future revisions to U.S. GOSIP.

6.4.2 International Standardized Profiles (ISPs)

ISO/IEC JTC1 has set up a Special Group on Functional Standardization (SGFS) to develop standards for International Standardized Profiles (ISPs). An ISP is somewhat more general than the common use of the term "profile" in that a profile is a stack of protocols to be used in combination, whereas an ISP is a document in which one or more profiles are published. The procedures adopted for specifying ISPs are unique because international harmonization is intended to be achieved before candidate ISPs are submitted to ISO. Proposals for ISPs are expected to be accepted by the international regional workshops EWOS,[23] NOIW, and the AOW before becoming proposed draft ISPs (PDISPs). As noted in Section 6.3.3.2, the SGFS has developed a six-part draft ISP for FTAM. Dozens of others are being discussed in the regional workshops.

The SGFS meets in plenary session in June of each year, 1991-1995.[24] The scope of the work of the SGFS is the following [SGFS N 293 1991]:

- Definition of functional standardization and functional standard
- Development of a catalogue of functional standards with appropriate classification
- Definition of a methodology for achieving functional standardization
- Development of a set of operating procedures and assessment of resources
- Execution of the review of proposed draft functional standards
- Consideration of the requirements of functional standards on conformance and maintenance
- Development of expeditious publication procedures.

The main work of the SGFS is the development of a framework and a taxonomy for ISPs (TR 10000), which gives priority to profiles for OSI but recognizes that the profile principles may also apply to other technical areas. This taxonomy contains a classification and identification scheme for candidate profiles, is being adopted by TSGCE SG9, and will be used in forthcoming editions of the *NTIS Transition Strategy*. TR 10000 identifies profiles (specification for how to accomplish a function) and ISPs (harmonized documents). TR 10000 allows an ISP to contain one or more profiles by permitting more than one part, each of which can contain a profile. It is expected that an ISP may contain 5

[23] EWOS taxonomy for profiles for open systems environments is given in Section 3.4.3.8.

[24] *Five-Year Meeting Schedule for JTC1/SGFS Plenary Meetings*, SGFS N 242.

to 10 profiles. Profiles may only be submitted to the SGFS by one of the three regional workshops (NOIW, EWOS, and Asia Oceania Workshop). Fifteen profiles were submitted to the SGFS in 1990, of which 4 were published and 11 are under review prior to balloting. An additional 15 profiles are expected to be submitted in 1991, and 25 more are under development in the regional workshops [SGFS N 295 1991].

The June 1990 meeting of the SGFS in Berlin addressed the progression of TR 10000 on taxonomy and work on conformance testing. Issues included distinction between base standards and ISPs, acceptance of standards as profiles, protocol profile testing methodology, need for more than one taxonomy, conformance to ISPs, multiple ISPs, complexity of profiles based on upper layer standards and relationship to the functions as defined by "service providers," application context, changes needed to incorporate ODA, and PICS proforma instructions [SGFS N 294 1991].

The Regional Workshops Coordinating Committee (RWS-CC) of ISO JTC1 has noted a number of harmonization efforts: conveyance of ODA over MHS(84); FTAM document types from CGM, COBOL, ODA, and EDI; a Document Application Profile (DAP) for raster graphics in ODA; general upper layer agreements; character set repertoires and their encoding; and an international registry (IR) or library (IMIL) [SGFS N 282 1991].

Table 18 shows the overall organization and labels (taxonomy) used to identify and distinguish ISPs. It shows the distinctions created by the choice of connection-oriented (CO) or connectionless (CL) modes (see Section 3.2.2). There are four classes of ISPs in the taxonomy of TR 10000: application profiles (*AXX nn* for those requiring the COTS and *BXX nn* for those requiring CLTS); interchange format and presentation profiles (*FXX nn*); transport profiles (*TX nnnn* and *UX nnnn* for CO and CL profiles, respectively); and relay profiles (*RX p,q*).

6.4.2.1 Interchange Format and Presentation Profiles

These profiles are coded by information type (three letters), document structure (first digit), and architecture (second digit). The information types are (the last two have no two-digit extensions):

- Office document: *FOD nn*
- Data stream: *F n*
- Virtual terminal control objects: *F n*

Table 18. Overview of Taxonomy for International Standardized Profiles

A	Application profiles using CO-mode transport service (TS)	
B	Application profiles using CL-mode TS	
F	Interchange format and representation profiles	
T	Transport profiles providing CO-mode TS	
	- TA	CO-TS over CL network service (CLNS) using Transport Protocol (TP) Class 4 as defined in ISO 8073/DAD2
	- TB	CO-TS over CO network service (CONS) with provision of TP Classes 0, 2, and 4
	- TC	CO-TS over CONS with provision of TP Classes 0 and 2
	- TD	CO-TS over CONS with provision of TP Class 0
	- TE	CO-TS over CONS with provision of TP Class 2
U	Transport profiles providing CL-mode transport service (TS)	
	- UA	CL-TS over CLNS
	- UB	CL-TS over CONS
R	Relay profiles between T- or U-profiles	

- Computer graphics: *FCG nn*
- SGML document: *FSG*
- Directory data definitions: *FDI.*

Section 4.1.1 lists the office document profiles under development.

6.4.2.2 Application Profiles

These profiles are coded by application supported and transport mode required (three letters, where the first letter is "A" if requiring COTS and "B" if requiring CLTS--no *BXX nn* profiles have yet been identified), service type (first digit), and functional association (second digit). The applications are :

- FTAM: *AFT nn*
- MHS (1984): *A/3 nn*
- MHS (1988): *AMH nn*
- VT: *AVT nn*
- TP: *ATP nn*
- RDA: *ARD*
- OSI Management: *AOM nn*
- Directory: *ADI n.*

Section 6.3.3.2 lists stable FTAM profiles that have been developed and are under development. Others are [OSN 1991c]:

- AMH 11, *MHS, Common Transfer Facilities: MTA to MTA (P1)*, Source: EWOS, 1991

- AMH 12, *MHS, Common Transfer Facilities: UA to MS (P7)*, Source: EWOS, 1991
- AVT 22, VT, *Basic Class (S-mode), Forms*, Source: EWOS
- AOM 11, OSI *Management, Basic Management Communications*, Source: EWOS, late 1991
- AOM 12, OSI *Management, Extended Management Communications*, Source: EWOS, 1991
- AD1, Directory, *Directory Access Protocol*, Source: NOIW

6.4.2.3 Transport Profiles

These profiles (Figure 11) are coded by transport mode (first letter "T" for COTS and "U" for CLTS), transport group (second letter), subnetwork type (first digit), access method (second digit), circuit type (third digit), and service type (fourth digit). The transport groups are CLNS (*TA* or *UA*), TP 0/2/4 over CONS (*TB* or *UB*), TP 0/2 over CONS (*TC*), TP0 over CONS (*TD*), and TP2 over CONS (*TE*). The subnetwork types are PSDN ("1"), digital data circuit ("2"), analogue telephone circuit ("3"), ISDN ("4"), and LAN ("5"). The access methods differ for circuits and LANs:

- Circuit access methods: permanent ("1"), switched ("2"), and packet mode ("3").
- LAN access methods: CSMA/CD ("1"), token bus ("2"), token ring ("3"), and FDDI ("4").

Profiles under development in this area include [OSN 1991c]:

- pDISP 10609, *Transport Profiles, Parts 1-9* [SGFS N 249-257, 19 July 1990]
- pDISP 10608, *Local Area Network Profiles, Parts 1, 2, and 5* [SGFS N 260-262, 19 July 1990]
- TA 52, *LAN, Token Bus: CLNS*, Source: NOIW
- TA 53, *LAN, Token Ring: CLNS*, Source: EWOS, January 1991
- TA 54, *LAN, FDDI: CLNS*, Source: AOW
- TC 1131, *PSDN: ISDN: B-channel semi-permanent, Virtual Call*, Source: EWOS, 1991
- TC 1231, *Switched Access to a PSDN: ISDN B-channel case: Virtual Call*, Source: EWOS, 1991
- TC 41. ISDN, *Semi-permanent Service*, Source: EWOS, 1991

- TC 42. ISDN, *Circuit-mode Service*, Source: EWOS, 1991
- TC 43, *ISDN, Packet-mode Service*, Source: AOW, 1991
- TC 51, *LAN CSMA/CD*, Source: EWOS, 1991
- TC 53, *LAN, Token Ring*, Source: EWOS, 1991
- TC 54, *LAN, FDDI*, Source: AOW.

6.4.2.4 Relay Profiles

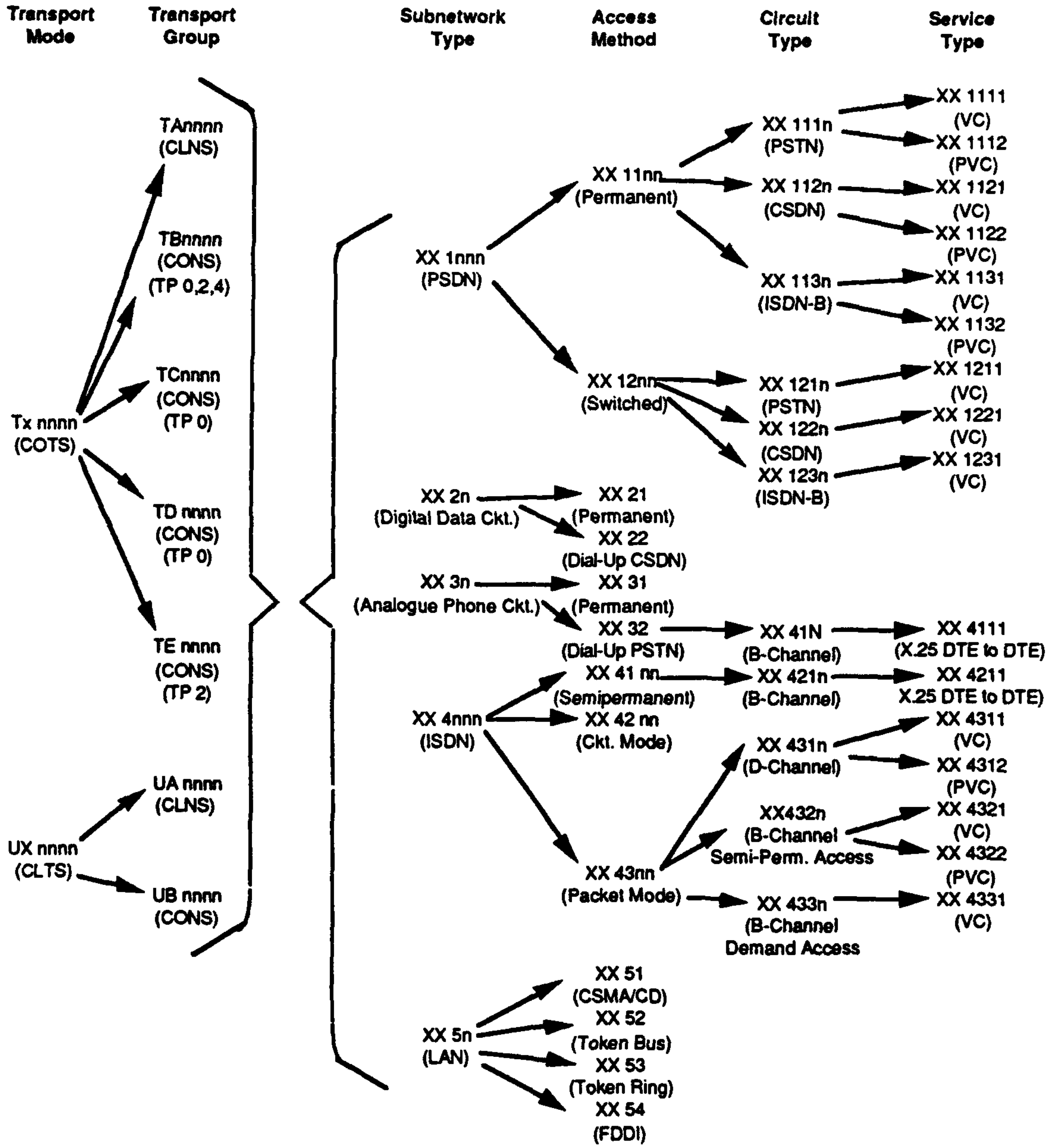
These profiles are coded by relay type:

- CLNS: *RA p,q*
- CONS: *RB p,q*
- X.25: *RC p,q*
- MAC using transport bridging: *RD p,q*
- MAC using source routing: *RE p,q*
- CLNS to CONS: *RZ p,q*.

The four-digit numbers p and q each use the four-digit numerical classification of the transport profiles. They thereby identify the subnetwork types between which the relay occurs.

Relay profiles under development include:

- RA51.51, *Relaying CLNS, CSMA/CD - CSMA/CD, Source*: EWOS, 1991
- RA51.1111, *Relaying CLNS, CSMA/CD - PSDN/Virtual Call/PSTN Leased*, Source: EWOS, 1991
- RA51.1121, *Relaying CLNS, CSMA/CD - PSDN/Virtual Call/Digital Cct. Leased*, Source: EWOS, 1991
- RC51.1111, *Relaying X.25 Packet Layer Protocol, CSMA/CD - PSDN/Virtual Call/PSTN Leased*, Source: EWOS, 1991
- RC51.1121, *Relaying X.25 Packet Layer Protocol, CSMA/CD - PSDN/Virtual Call/Digital Cct. Leased*, Source: EWOS, 1991
- RD51.51, *Relaying MAC Serv. Using Transparent Bridging, CSMA/CD - CSMA/CD*, Source: EWOS, 1991
- RD54.54, *FDDI-FDDI*, Source: AOW, tbd.



Source: [Onufer 1990].

Figure 11. Taxonomy for International Standard Transport Profiles

6.4.3 U.K. and U.S. GOSIP

This section discusses U.K. GOSIP and U.S. GOSIP, illustrated in Figures 12 and 13. Documentation for U.K. GOSIP was originally issued in March 1988 for mandatory use in 1990. It is now in version 4 [OSN 1991i, 19]. Figure 12 shows the standards recommended for U.K. GOSIP. Documents for version 3.1 of U.K. GOSIP, *U.K. Government OSI Profile* are [CCTA 1990; CCTA 1990a; CCTA 1990b]:

- Volume I, *Introduction*
- Volume II, *Specification*
- Volume III, *Procurement Handbook.*

Figure 13 shows the standards and options recommended for U.S. GOSIP, Version 2.0 [GOSIP 1990]. These are based on the March 1990 *Stable Implementation Agreements for Open Systems Interconnection Protocols,* Version 3, Edition 1, of the regional NIST OSI Implementor's Workshop [NIST 1990b]. Version 1.0 was issued as FIPS 146 on 3 August 1988. Version 2.0 was issued as FIPS 146-1 on 3 April 1989. Use of FIPS 146 was mandatory August 1990 and FIPS 146-1 will be mandatory 3 October 1991.

Whereas in Version 1.0 of U.S. GOSIP only the CL-mode network layer protocols were recommended for packet switched wide area networks (WANs), Version 2.0 makes CO-mode network service optional. This, and the addition of the Network Service Access Point (NSAP) address structure, will align the standard with those currently being addressed by ISO.

In addition to recognizing, including, and resolving Version 1.0 errata, Version 2.0 of U.S. GOSIP, published in October 1990 [GOSIP 1990], also includes the following protocols: VT (forms profiles and TELNET), ODA/ODIF, ISDN, connection-oriented network service, connectionless transport, and end-system to intermediate system (ES-IS) network layer protocols. These protocols would be added in Version 3.0, which is planned for 1995: Directory services (CCITT X.500), VT (page, scroll, and forms), 1988 CCITT extensions to MHS, FTAM extensions, FDDI, optional Transport Class 2, Computer Graphics Metafile, MMS, network management, optional security enhancements, SGML, EDI, and intra-domain routing protocols. Version 4.0, planned for 1997, will include transaction processing (TP), remote database access (RDA), additional network management, additional optional security, and inter-domain routing protocols [OSN 1991e, 4].

Future versions of U.S. GOSIP will continue to be based on the agreements reached in the regional NIST OSI Implementor's Workshop. Working agreements from the NOIW that have not reached final form are found in the *Working Implementation Agreements for Open Systems Interconnection Protocols: Continuing Agreements*. These agreements provide the basis for projections of U.S. GOSIP for 1992 and beyond.

A detailed description of the plans, based on U.S. GOSIP, to introduce OSI protocols into the U.S. DoD is provided in *The Department of Defense Open Systems Interconnection (OSI) Implementation Strategy* [Mitre 1988]. The baseline for U.S. tactical implementation of OSI standards and protocols will be based on the work of TSGCE SG9, the *NTIS Transition Strategy*, and associated STANAGs. Tactical networks may use GOSIP-specified lower-level protocols until NTIS protocols are developed and commercially available. When the NATO standards are complete, approved, and available, those required for DoD use will be introduced as GOSIP Advanced (post-1989) Requirements [Mitre 1988].

While some major vendors such as IBM are offering (or about to offer) OSI for much or all of their product line, they are typically offering TCP/IP as well. The 15 August 1990 GOSIP mandate seems to have influenced the schedule for many of the OSI implementors, so a number of first generation OSI products either are just appearing or expected shortly. Activity in the TCP/IP product lines is undiminished [PSSG 1991].

NIST is publishing a series of GOSIP evaluation guidelines that are now available for electronic mail and transfer. These guidelines explain how implementations can differ, and they assist Federal agencies and other users in determining which among several implementations best suits their needs [OSN 1991e, 5].

Since Version 3 of GOSIP will be introducing standardized network management, an important area where a lot of standards work remains to be done, NIST is developing a number of FIPS concerning network management. They will be published in stages, one each year for the next three years, and will describe the objects that have to be managed to perform network management or OSI management in the following functional areas:

- Phase I: 802, X.25, ISDN, FDDI, modems, multiplexors, bridges, and physical link
- Phase II: protocol software, routers, terminal services, MTAs, PBXs, and circuit Sswitches
- Phase III: applications, services, operating systems, computer networks, and DBMSs.

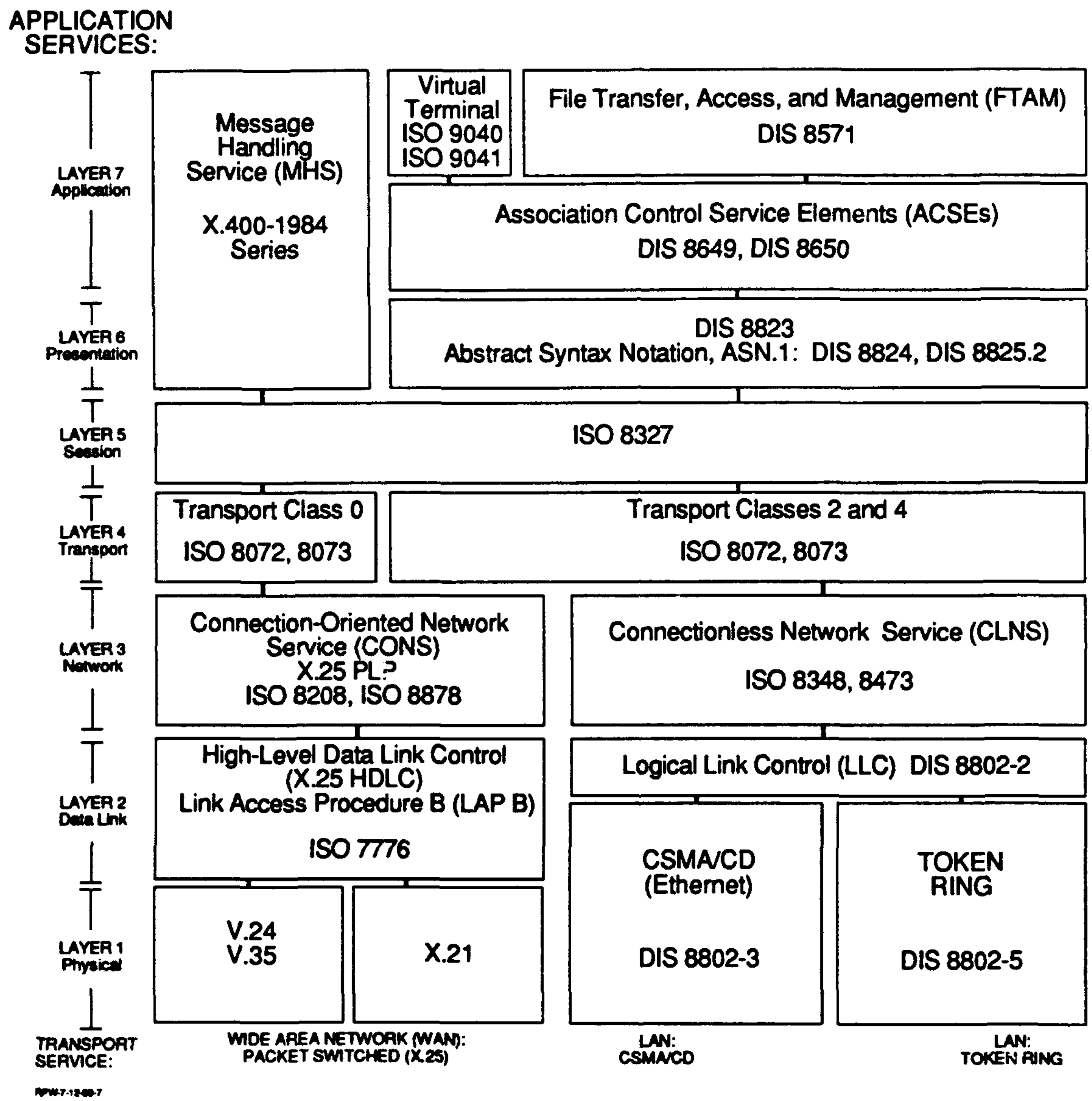


Figure 12. Stacks of Standards Recommended for U.K. GOSIP

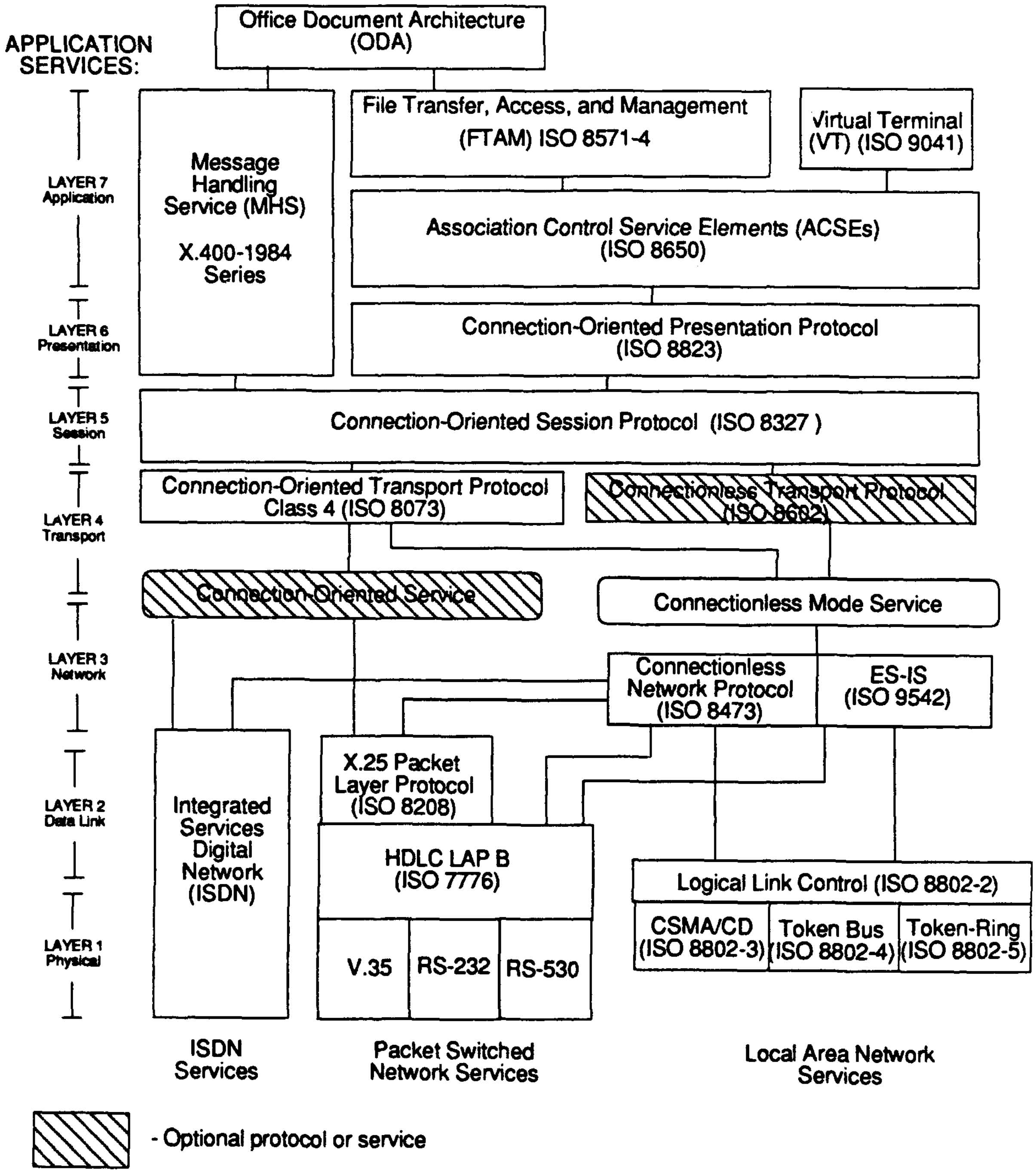


Figure 13. Stacks of Standards Recommended for U.S. GOSIP (Version 2.0)

The staging of these FIPS reflects user priorities. In a survey of Federal agencies, NIST found that the most important area is management for local area networks and Layers 1 and 2 of the OSI Reference Model. Next were Layers 3-7 and then network management applying to operating systems, applications, and services [OSN 1991e, 7].

6.4.4 European Procurement Handbook for Open Systems (EPHOS)

Decision 87/95 from the European Community (EC) requires the specification of OSI standards for public procurements. A document is being developed by France, Germany, and the United Kingdom to provide guidance for such procurements. The document is called the European Procurement Handbook for Open Systems (EPHOS) and is based on base profiles of the U.K. GOSIP specification. Where possible, EPHOS will cite European standards and ISPs.

In early 1991, EPHOS achieved two significant milestones. The Phase I draft covering X.25, MHS, and FTAM now reflects member nations' formal comments, and Phase II has progressed to the point of agreement on further coverage. The original intention to publish procurement guidance on MHS-88 has been undermined by slow progress on the European standards, and EPHOS Phase I has been revised to focus on MHS-84 with only preliminary guidance on specifying MHS-88 added functionality. Phase II topics will include: Phase I maintenance, FTAM, MHS-88, LAN, cabling, document formats, character repertories, Security, EDI, directory services, VT, LAN/WAN interworking, and identification of areas where standards are inadequate or absent [OSN 1991g].

6.4.5 International Versions of GOSIP

Initiatives have been taken to develop an international version of GOSIP. The initial meeting in October 1988 was sponsored by the United Kingdom, with participation from France, Germany, Canada, Japan, Sweden, and the United States. The next meeting in Japan will highlight attempts to gain support from other Pacific nations.

6.4.6 NATO Standardized Profiles

A number of profiles have been developed in TSGCE SG9. These include (see Appendix H) the *Military Message Handling System* (draft STANAG 4257), R.131(M)--*Relay for Connecting PSDNs using X.75*, TC 111(M)--*Permanent Access to a PSDN*, and TA 51(M)--*COTS over CLNS and CSMA/CD LAN*. Profiles identified in the *NTIS*

Transition Strategy are described in Tables 14, 15, and 16 of Section 6.3.1 and more fully in Appendix B. TSGCE SG9 is considering developing a NATO OSI standard profile along with lines of U.K. and U.S. GOSIP.

6.4.7 Other Profiles and Transition Strategies

This section is intended to be expanded to address additional activities and options to support transition from existing military and other standards to standards for open environments. Examples are application gateways, test systems, and test methodologies. Efforts to highlight functional standards, select stacks of mature standards and options within standards, and harmonize implementations will be examined. One example is the *Guide to the Use of Standards* [SPAG 1987] developed by SPAG in Europe. Functional standards based on OSI standards are being developed by the Interoperability Technology Association for Information Processing, Japan (INTAP), specifically towards an interoperable distributed database system [Konoike 1987]. Recommendations for functional standards and cooperation with European and U.S. organizations and companies are also provided in Japan by POSI.

6.5 OSI Environments

6.5.1 ISO Development Environment (ISODE)

ISODE is prototype software, developed as a tool to study OSI. In the current vacuum of OSI implementations; however, ISODE has become a default reference implementation of the OSI upper-layers, a platform for deploying OSI services, and a means for transitioning from TCP/IP to OSI protocols.

The ISODE software supports various OSI protocols and applications. ISODE is aligned with U.S. GOSIP. The current modules include the following [Rose 1990]:

- OSI transport service (TP0 on top of TCP, X.25, and the CO network service; TP4 for SunLink OSI)
- OSI session, presentation, and association control services
- ASN.1 abstract syntax/transfer notation tools
- OSI reliable transfer and remote operations services
- FTAM/FTP gateway
- OSI Directory services
- OSI VT (basic class and TELNET profile).

6.5.2 COS/COSINE Recommendations

Initial profiles for Cooperation for Open Systems Interconnection in Europe (COSINE) have been released. These profiles are summarized in Table 19. In addition to those standards cited in the table, COSINE is evaluating:

- Virtual Terminal, ISO 9041 (with AD2 screen mode)
- EWOS Profile A/122 for file access
- Additional message handling services (CCITT X.400-1988)
- Job Transfer and Manipulation (JTM), ISO 8832 and ISO 8833.

Table 19. Standards for COSINE Profiles

Layer	References for Standards
7. Application	ENV 41204 (FTAM) ENV 41910 (Remote Terminal Access) EWOS Profile A/111 (File Access) RARE MHS and CCITT X.400-1884 MHS Services Remote Job Entry (to be defined in EWOS)
6. Presentation	(Null Layer)
5. Session	(Null Layer)
4. T ransport	(Connection-Oriented)
3. Network	(Connection-Oriented)
2. Data Link	CCITT X.25-1984
1. Physical	Local Area Networks (not specified)

6.6 Assessment of Coverage by Standards

MHS-88 provides a number of the military features identified by the U.S. PSSG, and the TSGCE SG9 WG2 (Upper OSI Layers) for a Military Message Handling System (MMHS). Work on a draft STANAG for MMHS that was based on MHS-84 was completed as an intercept strategy, and analysis is now being performed in TSGCE SG9/WG2 to identify additional features required for military application of MHS (see Appendix K). Analysis of the relationship of MHS to ACP 129 and Abstract Syntax Notation One (ASN.1) to STANAG 5500 and other message standards is needed. NATO has requirements for media independent data communications protocols (e.g., for Link 1 replacement) that have not yet been developed; these standards could be applicable to the communications services, and more work needs to be done in this area (see Appendix K).

Allied Communications Publication (ACP) 127 is a NATO standard for message handling services. In a comparison of the 65 service elements of ACP 127, a recent

analysis [USPR 1989] has identified 55 as common to MHS-88. An additional five service elements were shown to be related to, but not the same as, those in ACP 127:

- Precedence levels (MHS-88 provides an Importance Indicator)
- Message identification (MHS-88 provides somewhat different features)
- Prosign C (MHS-88 has an obsoleting indication)
- Bell signal (MHS-88 provides a stored message alert)
- Date-time group (MHS-88 has a submission time stamp).

Five services provided in ACP 127 are not supported in MHS-88: financial accountability, service message, network continuity indication, off-line accountability, and tracer action. Version 4 of STAMINA provides MHS-84 services and ACP 127 functionality (see Appendix K).

ISO SC21/WG1 is still refining the OSI Reference Model regarding the specification of the boundaries of Layers 1 and 2. Some of the protocols needed for the communications services may be determined to lie outside the Reference Model. These might include forward error correction coding[25] (several ISO standards provide for error detection) and other mechanisms such as interleaving of bits from a sequence of octets to reduce the impact of the environment on certain transmission media. Protocols for handling requirements of cryptographic devices (e.g., synchronization) and media access may also lie outside the Reference Model. Standardization of these features should, wherever possible, be accomplished with media-independent standards.

Network services can be provided for WAM using OSI protocols for electronic mail, Directory, file management, and exchange of telematic information and documents. ISO and CCITT have made great strides in the last five years in getting agreements in many areas of OSI and bringing the base standards to mature status. Directory and MHS-88 are two of the major achievements during the past two years. At the present time there are not many high-level services provided by the OSI stacks, but the communications aspects at lower layers is mature for connection-oriented services and maturing rapidly for connectionless-mode services. Some issues and related findings for communications services are:

25 Whether forward error correction (FEC) is outside of the OSI Reference Model is still a contentious issue in ISO, U.S. PSSG, and NATO. Valid arguments exist for FEC at either layer 1 or layer 2.

- Lack of capability to cross between connection-oriented and connectionless-mode services in OSI stacks. The OSI Reference Model is now being revised to incorporate connectionless services (previously treated as an addendum). Most work on crossover is being addressed by transport or relay bridges, some of which do not conform to the Reference Model. This is a major problem for interoperability between North America (which uses predominantly connectionless modes) and Europe (which uses predominantly connection-oriented modes). As an example, U.S. and U.K. GOSIP are not compatible and no progress has been made to converge these efforts. However, Version 2.0 of U.S. GOSIP includes an optional connectionless transport service and an optional connection-oriented network service for use on end-systems connected to X.25 networks that are not going to be connected to local area networks.

- Few international standardized profiles (ISP) have been adopted by ISO. Work on FTAM profiles is the most mature and three of the FTAM ISPs have been adopted by ISO. EWOS is preparing a number of candidates for adoption in ISO, but these emphasize connection-oriented services. Profile work in NIST is progressing rapidly, but the products are not yet in the form that can be used for an ISP. Adoption of common ISPs is critical to the compatibility of products based on OSI and other open system protocols.

7. OPERATING SYSTEM SERVICE STANDARDS

7.1 Requirements

Operating system services allow applications to gain access to system resources in terms of task initiation, management, scheduling, resource allocation, logical and physical device access, interrupt handling, communication, synchronization, accounting, file management, and a range of utilities that assist efficient development, testing, and execution of applications software. Operating system services address kernel services, commands and utilities, system administration and management, and security.

7.2 Standards for Operating System Services

The key enabler for standardizing operating system services is the use of a robust standard for the operating system *interfaces*. If the interface standard is sufficiently robust (providing a wide range of services), then adherence to the standard can provide the needed functionality without having to be limited on choice of an operating system and thereby an operating environment. Many implementations available today provide the basic operating system interface. Use of options for additional services outside a standard interface could defeat the goal of adopting a standard interface for operating system services, namely ensuring a high degree of applications portability while providing the necessary system services for information exchange and applications.

7.2.1 POSIX

The Portable Operating System Interface for Computer Environments (POSIX) is an interface standard for operating systems that is designed to be vendor independent and to promote application portability. Development of the POSIX standards is through the Institute of Electrical and Electronics Engineers (IEEE) Computer Society's Technical Committee on Operating Systems (TCOS). The TCOS has formed a large number of working groups. These working groups and the POSIX standards being developed are identified by the same label, namely P1003 with an appropriate extension. Of these, only two, IEEE 1003.1 and IEEE 1003.3 have achieved standards status. The scope and status of the POSIX work in IEEE is provided in Table 20.

Table 20. POSIX Standards Being Developed by the IEEE Computer Society, Technical Committee on Operating Systems for Submission to ISO Through ANSI

P1003.0, *POSIX Guide*--accelerates consensus on Open Systems for Applications Portability and provides timely guidance to users on how to develop applications profiles. (Draft 11, March 1991, to be balloted in February 1992)

P1003.1, *POSIX - System Interface* --defines a standard operating system interface and environment to support application portability at the source code level (approved by ANSI in November 1989 and revised September 1990; approved by ISO as ISO 9945-1, December 1990. IEEE P1003.1-1988 approved as FIPS 151-1, March 1990.

P1003.1a *Language Independent Specifications*--provides editorial corrections that respond to concerns in balloting. (Draft 5, December 1990) (Ballot spring 1992; target completion late 1992)

P1003.1b *System Interface Extensions*--adds functions and provides preparatory work for language-independent specifications. (Draft 5, December 1990) (IEEE balloting planned for late 1991.)

P1003.2, *Shell and Utilities*--defines a standard source-code-level interface to shell services and common utility programs for applications programs. (Draft 11 balloted February 1991) (IEEE standard expected late-1991 to early 1992) (Draft 10 was submitted to ISO and balloted as DP 9945-2, but failed.)

P1003.2a *User Portability Extensions*--provides extensions...to support terminal users in a consistent manner across all conforming systems. (Draft 6 balloted March 1991) (IEEE standard expected late-1991 to early 1992)

P1003.3, *Test Methods: General*--defines general requirements and test methods for test suites to measure conformance of an implementation to IEEE POSIX and related standards; seeks to define what to test rather than how to test and promotes the development of testable standards. (IEEE 1003.3-1991 approved March 21, 1991)

P1003.3.1, *Test Methods: System Interfaces*--defines test methods and requirements for implementations of test suites to measure conformance of an operating system product to POSIX P1003.1. (Draft 12 balloted April 1991; approval of final text expected late in 1991 to early 1992.)

P1003.3.2, *Test Methods: Shell and Utilities*--defines test methods and requirements for implementations of test suites to measure conformance of an operating system product to POSIX P1003.2. (Draft 4, February 1991; to be balloted mid-1992; approval of final text expected early 1993.)

P1003.4, *Real-Time Extensions*--defines a real-time extension to POSIX environments. (Draft 10 balloted February 1991; approval expected late 1991)

P1003.4a, *Threads*--defines interfaces for handling multiple threads of control within a single POSIX P1003.1 process. (Draft 5, November 1990; balloted January 1991.)

P1003.4b, *Language-Independent Specifications*--rewrites interfaces defined in P1003.4 and P1003.4a into a language-independent binding.

P1003.4c, *Extensions to P1003.4*--extends interfaces defined in P1003.1 and P1003.4 to include additional real-time facilities. (Draft 10, January 1991; balloting was planned for 2Q 1991.)

P1003.5, *Ada Language Binding*--determines the Ada environment interface and Ada extensions required for POSIX; provides a specification for the Ada environment interfaces and Ada required extensions so that applications programs can be written to operate consistently on all conforming POSIX/Ada environments. (Draft 7 balloted June 1990; approval expected in 1Q 1992)

P1003.6, *Security Interface for POSIX*--develops specifications for standard interfaces to security services and mechanisms for portable applications to include Systems Call Interfaces and System Commands. (Draft 10, March 1991; Draft 11 balloted May 1991; approval expected mid-1992)

P1003.7, *System Management (name changed from System Administration Interface)*--defines a standard interface to utility programs for administering systems that conform to POSIX. (Draft 5, February 1991; ballot planned for April 1992)

P1003.8, *Transparent File Access (TFA)*--develops system interfaces and other mechanisms to permit portability of applications into environments where files, directories, etc., may reside on remote systems. (Draft 4, November 1990; balloting was planned for summer 1991.)

Table 20. (Continued)

P1003.9, *FORTRAN Language Binding*--defines a FORTRAN-1977 language binding to applicable POSIX interfaces and functionality as specified in P1003.1,2,4, etc., and establishes an interface for FORTRAN to POSIX such that FORTRAN applications using POSIX functionality will be portable at the source code level. (Work based on results of /user/group; Draft 8 balloted November 1990)
P1003.10, *Supercomputing Application Environment Profile (AEP)*--develops an AEP for supercomputing environments. (Draft 5, March 1991)
P1003.11, *Transaction Processing*--develops a standard profile for transaction processing application environments. (Draft 2, March 1991; mock ballot planned for January 1992; ballot expected mid-1992)
P1003.12, *Protocol Independent Interfaces*--defines programmatic interfaces that allow a portable application to communicate with another entity in the network such that the application may be independent of the underlying protocols. (Working pre-draft January 1991; balloting planned for 1992.)
P1003.13, *Real-Time AEP*--defines an AEP for real-time applications using the POSIX interfaces; addresses three profiles: full-function real-time system, embedded control system, and intermediate real-time system. (Draft 1, April 1990; balloting was planned for early 1991.)
P1003.14, *Multiprocessing Application Support AEP*--defines an AEP for multiprocessing applications environments based on relevant POSIX standards. (Draft 2, January 1991; balloting planned for October 1991.)
P1003.15, *Batch Environment Amendments*--define utilities, library routines, system administration interfaces, and a host-to-host protocol to provide a network queueing and batch system in a POSIX environment. (Draft 5, January 1991, balloting was planned for July 1991.)
P1003.16, *C Language Binding*. (Balloting expected in fall of 1991)
P1003.17, *Directory Services API*--defines an application programming interface to a directory service,...X.500 functionality . (Draft 0, January 1992; balloting planned for 1992)
P1003.18, *POSIX Platform Profile*--establish a Platform Environment Profile based on the ISO 9945 work and related standards which describes a simple foundation for an interactive, multiuser application platform. (Group formed October 1990; Draft 3, January 1991)

Source: [Martin 1991a].

POSIX 1003.0 is going to mock ballot in August 1991 in preparation for a real ballot in February 1992. NIST issued FIPS 151-1 based on the 1988 version of IEEE 1003.1. NIST held a workshop in the summer of 1991 to discuss the possibility of moving to a FIPS 151-2 based on the 1990 revision to the IEEE standard. POSIX 1003.1 was provided to ISO by the ANSI. WG15 of SC22 within the JTC1 was formed in September 1987 and assigned responsibility for POSIX. The IEEE standard P1003.1 has been adopted as ISO 9945-1. WG15 eventually intends to remove the focus on UNIX and the C language to create a generic interface specification between any language and a multiuser environment. WG 15's division of work items is as follows:

- ISO 9945-1, *System Interface* (P1003.1 and .1a)
  - DP 9945-1.1, *Language Independent Base* (P1003.1c)
  - DP 9945-1.2, *Realtime and Extensions* (P1003.4 and .1b)
  - DP 9945-1.3, *Distribution Services* (P1003.8)
    - DP 9945-1.3.1, *Transparent File Access* (P1003.8)

DP 9945-1.3.2, *Remote Procedure Call* (P1237)

DP 9945-1.3.3, *Transport Interface* (P1003.11)

DP 9945-1.3.4, *Name Space/Directory Services* (P1003.12)

- DP 9945-2

  DP 9945-2.1, *Shell and Utilities* (P1003.2)

  DP 9945-2.2, *User Portability Extensions* (P1003.2a)

- DP 9945-3, *System Management*

  DP 9945-3.1, *General Services* (P1003.7)

  DP 9934-3.2, *Batch Services* (P1003.10).

Part 2 of the POSIX standard is for interfaces to shell and utilities (P1003.2). Draft #9 of IEEE P1003.2 was submitted[27] to ISO through ANSI as DP 9945-2. It failed the registration ballot, however, and the project is now on hold since a new draft was requested for registration. Part 3, *Test Methods (General),* was approved as IEEE standard 1003.3-1991 on March 21, 1991.

ANSI is developing a standard interface for the C language (X3J11) that is compatible with POSIX. As shown in Table 11, IEEE is working on Ada, FORTRAN, and C bindings for POSIX; the Ada binding should be complete in 1992. POSIX is intended to be compatible with both Database Language SQL and IRDS database management languages, as well as with OSI data communications and interprocess communications.

Other planned FIPS based on the POSIX standards include a Transparent File Access FIPS based on P1003.8 and a System Management FIPS based on P1003.7. Plans are to make the initial FIPS proposal for the Transparent File Access FIPS in late FY 1991 with the expectation that a FIPS would be approved by 1992. The System Management FIPS is only in the early planning phase, and an initial FIPS proposal will not be forthcoming until 1992.

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27 P1003.2 (Draft #9, 1989) was proposed as a FIPS, however; it was determined that draft was not sufficiently mature or stable to become a FIPS.

7.2.1.1 POSIX Conformance Testing

The NIST Computer Systems Laboratory (NCSL) has developed a POSIX Conformance Test Suite (PCTS) based on IEEE 1003.1, Draft 10. The suite was in beta testing for over a year and is available from the National Technical Information Service (NTIS). The NIST National Voluntary Laboratory Accreditation Program (NVLAP) will accredit testing laboratories which will be referred to as Accredited POSIX Testing Laboratories (APTLs). On May 1, 1991, NVLAP announced the initial group of seven labs. The policy document for POSIX Conformance Testing is *NVLAP Program Handbook Computer Applications Testing - POSIX Conformance Testing*. Testing is done through agreement between the testing lab and the client, without NIST/CSL involvement. However, NIST/CSL issues the certificate of validation [Hall 1991].

The Conformance Testing Service has established a CTS-2 POSIX Project with the goal of a harmonized European and internationally recognized conformance testing service for POSIX. Participants in the project include the National Computing Centre Ltd (UK), the Computer Resources International A/S (Denmark), X/Open Company Ltd (UK), and British Telecommunications (UK). The project will be establishing test laboratories throughout Europe and seeking cross recognition with NIST [Pink et al. 1991].

7.2.2 Consortia Recommendations

Standards activities in areas related to the operating systems have been primarily in the area of developing international, nonproprietary standards for *interfaces* to operating systems. It appears unlikely that an international standard for an operating *system* will be developed, in part because operating systems are closely tied to the hardware architecture of vendor products.

As indicated earlier, POSIX is becoming a widely accepted approach to standardizing interfaces to operating systems; the initial standard for POSIX (ISO 9945-1) has been completed. Consortia have been formed to develop and promote profiles of standards that could be the basis for open environments and portable systems within these environments. All the consortia have adopted POSIX; however, there are differences in the approaches being taken. Activities of these consortia in the POSIX area are discussed in this section; additional information on portability profiles is provided in Section 3.4.3.

The international nonprofit consortium X/Open is developing extensions to UNIX System V Interface Definition (SVID), which will define a distributed (two-phase)

transaction processing environment that meets OSI standards. A layered functional model for this environment that consists of resource, commit, and transaction management has been proposed. This model requires certain extensions to the UNIX kernel (guaranteed output to files and concurrent input from peripherals). The X/Open System V Specification (XVS) is the initial recommended standard for the operating system. The extensions would be part of a Common Applications Environment (CAE), a concept to promote software portability. This would be achieved by adopting and adapting existing industry and *de facto* standards, rather than by creating a new standard. Future goals for the CAE are alignment with POSIX P1003.1 (with a large number of extensions) and ANSI X3J11 C together with interfaces for Indexed Sequential Access Method (ISAM) and an embedded standard Relational Database Language (SQL). The X/Open version of ISAM is based on a major (implementation nonspecific) subset of C-ISAM Version 2.10 (January 1985) from the Informix Corporation. The initial X/Open version of SQL is not fully compliant with ANSI X3.135-1986 [X/Open 1987; X/Open 1988; Lambert 1987]. Standards recommended for the CAE are discussed in Section 3.4.3.4.

Another approach to developing standard interfaces to UNIX-type systems is being taken by the OSF, an international consortium formed in May 1988. In December 1990, it issued the first release of its OSF/1 operating system. OSF has integrated a number of existing advanced technologies into its vendor-neutral operating systems. Sections 3.4.2.4 and 3.4.3.5 discuss OSF and OSF/1.

A third approach to developing POSIX-conformant operating systems is underway. This approach is based on providing a version of the Berkeley UNIX with a POSIX interface.

A fourth approach has been announced by the consortium called OPEN88. This consortium is reported to be planning to have a POSIX-conformant version of UNIX.

The NIST has developed an APP as an approach to identifying standards that could be used to achieve an open environment that would ensure a high degree of applications portability. In addition to the operating system, this environment includes data management, data interchange, network services, user interface, graphics services, and programming services. Security and system management services underlie the seven basic services since they are integral to them all. In addition to providing open systems interconnection, NIST believes POSIX is the key to such an environment. NIST has identified [Hankinson 1988] a number of areas in which the current POSIX definition must be extended in order to "provide full operating system functionality." These extensions

include shell and tools, system-administration, and terminal interface extensions. Extended POSIX would be part of an integrated set of non-proprietary standards. Efforts are still required to specify the appropriate standards and "bindings" for the open environment. The complete APP proposed by NIST, together with the status of relevant standards other than POSIX, is discussed in Section 3.4.3.3.

7.2.3 Operating System Standards

When common operating systems are used, there is a potential to reduce the development of CCIS system elements by sharing software. Even when different operating systems are used, adoption of operating system interface standards can increase application software portability. In WAM, the recommended approach would be to agree on a standard operating system *interface* (i.e., POSIX), but *not* to seek agreement on a standard operating system. Standards for applications portability are addressed in Section 3.4.3.

SC21 has begun work in the area of Operating Systems Command and Response Language (OSCRL). A draft proposal for OSCRL is planned, but has not yet been promulgated.

Two communities of operating systems standards have received strong support from vendor groups promoting application portability. One group is UNIX International (formerly Archer, with a membership of 42 corporations and user groups), which promotes UNIX System V, a proprietary standard of AT&T. Availability of Release 4.0 of UNIX System V was announced at the UNIX EXPO (November 1989) and is now commercially available. This release aims to:

- Merge all the major versions of the UNIX operating system (i.e., the /user/group Xenix, the Berkeley 4.x BSD, and the Sun Operating System)
- Enhance data networking with the addition of Remote File Systems and Remote Procedure Calls
- Address real-time applications and environments
- Ensure conformance to POSIX through enhanced signal handling, multiple groups and ownership, and job control
- Achieve and maintain full compliance with the X/OPEN CAE.

The other major group promoting operating systems is the OSF, which has adopted the IBM AIX Version 3 of UNIX. This version conforms to POSIX, and future releases will comply with Issue 3 of the X/Open Portability Guide (XPG3). IBM intends to

support both TCP/IP and OSI protocol (to include X.25) that will operate over various physical connections. Other features of this operating system are the provisions for network management functions via OSI's Common Management Information Service/Protocol (CMIS/CMIP), electronic mail via X.400, and presentation services via X-Windows [OSN 1990j].

7.3 Assessment of Coverage by Standards

Standardization of operating systems appears unlikely. Further, there is no need to select a standard operating system for WAM, since such a selection is viewed as an implementation issue. When mature, adopting the POSIX interface standard for CCISs appears to be an attractive option, both to achieve some of the required system services and to promote applications portability during implementation. Adoption of the current POSIX standard would probably not fully meet system service requirements. For example, POSIX addresses independent operating systems cooperating in a distributed environment, not a single operating system running on multiple machines. It is not specifically designed for distributed applications, and therefore may not serve a CCIS's needs completely. However, further refinement of the WAM requirements and extensions of the POSIX standard are needed to assess additional requirements for WAM.

8. PROGRAMMING SERVICE STANDARDS

This chapter identifies programming languages, software development environments, tool sets, process models, and methodologies, and other programming service standards. It needs be expanded to address specific tools such as compilers, syntax (e.g., ASN.1) analyzers, and other support tools.

8.1 Requirements

Programming language services address the sets of tools that support requirements definition, system development, testing, maintenance, and administration. They also address CASE, software development environments and tools, and library support.

In order to satisfy the overall CCIS requirement for using COTS/NDI hardware and software, software must be both portable and interoperable. Moreover, a multitude of applications ranging from data analysis to word processing will need to be integrated. Requirements for the efficient production of effective software dictate the use of software development environments and tools as well as reuse libraries. As the technology evolves, needs for expert system support in the software production process will arise.

8.2 Programming Languages

8.2.1 Ada Programming Language

Ada is a programming language agreed to be used within NATO and the U.S. DoD[28] as a standard general-purpose high-level programming language. It was introduced in 1979 after the U.S. DoD became concerned about the proliferation of computer languages it was using and determined that none of these languages was suitable for writing DoD software. Ada uses the latest ideas in language design and a standard programming support environment is suggested. In 1983 it was adopted as a standard by ANSI and as a U.S. Military Standard (MIL-STD-1815A). It was adopted as a Federal Information Processing Standard (FIPS 119) on 8 November 1985. In 1987 ISO endorsed it as an ISO standard (ISO 8652).

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[28] DoD Directive 3405.1 states that Ada is the preferred computer programming language for all DoD applications except when the use of another higher order language is most cost effective over the application's life cycle. DoD Directive 3405.2 mandates the use of Ada in all computers integral to weapons systems (embedded systems).

In 1988, the Ada 9X project was undertaken to revise ANSI/MIL-STD-1815A through a three step process: (1) requirements development, (2) revision of the Ada Language Reference Manual, and (3) implementation demonstrations. In May 1990 the requirements process culminated in the publication of the *Ada 9X Project Report: Ada 9X Revision Issues*, Release 2 [Ada 9X 1990]. Whether or not Ada will be fully upwardly compatible with Ada 9X is currently unknown. However, revisions to Ada will be subjected to public review and comment before becoming part of the revised standard. It is expected that most changes will be upward compatible with existing compilers and tools.

8.2.1.1 Ada Programming Support Environment (APSE)

An APSE is an environment for developing software systems written in Ada. At its core is a kernel APSE (KAPSE), which represents general operating system services such as file management services and process and device control services, as well as object management services. It is at this level, as opposed to the outer layers, the MAPSE (Minimal APSE) and APSE, that a common set of interfaces is required. The MAPSE consists of software tools that minimally support software development, such as compilers, editors, and linkers, while the APSE provides project-specific tools and services.

8.2.1.2 Common APSE Interface Set (CAIS)

CAIS provides a common set of interfaces to the KAPSE. The CAIS standard (U.S. DoD MIL-STD-1838A, 1989) defines a set of interfaces that allows APSE tools to use common operating services and facilities in a standardized fashion. The original plan for the designing of CAIS in the U.S. called for one set of interfaces to be produced at the end of 4 years' work (the original target was 1987). As pressure mounted for an earlier release, the Ada Joint Program Office (AJPO) decided that a limited capability version should be provided before the full CAIS was complete.

The first version of CAIS (U.S. DoD MIL-STD-1838) was published in October 1986. It comprised only those interfaces common to two different APSEs being developed by the U.S. Army and the U.S. Air Force: the Ada Language System (ALS, for the Army) and the Ada Integrated Environment (AIE, for the Air Force). Because of divergent approaches at the KAPSE interface level taken by the ALS and AIE contractors, the KAPSE Interface Team (KIT) and the KAPSE Interface Team from Industry and Academia (KITIA) were formed. Together, the KIT/KITIA produced the first version of the CAIS.

In parallel, the Requirements and Design Criteria Working Group (RACWG), composed of KIT and KITIA members, was established in July 1983 for the purpose of defining a set of requirements and criteria for the design of a second version of the CAIS. In 1985, a contract was awarded to SofTech, Inc., to continue development of this second version of CAIS (CAIS-A). CAIS-A was reviewed publicly in 1987 and was published as a military standard (MIL-STD-1838A) on April 6, 1989 [AJPO 1989].

There are no plans, nor is a mechanism currently in place, to update CAIS-A. While at least two implementations of CAIS-A now exist, one by SofTech for the VAX/VMS environment and one by UNISYS for the Sun/UNIX environment, the effort is generally suffering due to a lack of commercial support.

However, there are plans to merge CAIS-A with a similar European standards effort the PCTE+ (Portable Common Tool Environment), over the next several years. The result of this merger will be the Portable Common Interface Set (PCIS). PCTE is an effort of the European Strategic Programme of Research and Development in Information Technology (ESPRIT) (see Section 8.3.2). Meetings to discuss PCIS are scheduled to begin in 1991 and the specification of PCIS is expected to be ready by 1994.

8.2.2 Pascal Programming Language

Pascal is a computer programming language originally designed to satisfy two principal aims. The first was to provide a language suitable for teaching programming as a systematic discipline based on certain fundamental concepts clearly and naturally reflected by the language. The second aim was to define a language whose implementations could be reliable and efficient on then-available computers. A Pascal standard was adopted in 1983 as ANSI X3.97 and IEEE 770.

At the same time that the ANSI/IEEE Pascal standard was being developed, the British Standards Institution (BSI) sponsored an ISO draft proposal for Pascal. In 1983, ISO adopted Pascal as a standard (ISO 7185), endorsing British Standard (BS) 6192-1982. While the ISO and ANSI/IEEE Pascal standards are compatible, there are some differences in technical substance as well as some errors in the ISO standard.

In January 1985 the U.S. Federal Government adopted the ANSI/IEEE standard as FIPS 109. The implementation of FIPS Pascal involves three areas of consideration:

- Acquisition of Pascal processors
- Interpretation of FIPS Pascal

- Validation of Pascal processors.

On 10 April 1990, ANSI X3 and the IEEE approved the Extended Programming Language Pascal standard as IEEE 770 and ANSI X3.160.

8.2.3 C Programming Language

C originated in the late 1970s as the programming language of the UNIX operating system. It is a general-purpose programming language that features economy of expression, modern flow control and data structures, and a rich set of operators.

C is not a very "high level" language, nor a complex one. Its particular area of application is systems programming (e.g., software for an operating system). Although it was originally implemented on a DEC PDP-11, it is now widely used [Kernighan et al. 1988].

Its growing popularity, changes in the language over the years, and the creation of compilers by groups not involved in its design raised the need for a standard in the early 1980s [Kernighan et al. 1988]. In 1989, ANSI promulgated X3.159, Programming Language C. In 1990, this standard was adopted by ISO (ISO/IEC 9899). It was also recently approved by the Federal Government as FIPS-160.

There is also an ASC X3 project (0743-D) to promulgate a standard for Programming Language C++, a higher-level update of C. There is no draft standard yet, but estimated completion is 1994.

Technical Committee X3J11 of ASC X3 is developing a technical report for numerical C extensions. The objective of the report is to outline the technical issues involved in adding more support for numerical programming in Programming Language C. The issues that have been identified are [X3 1991h]:

- Optimization of potentially aliased variables
- Support for vector hardware
- Complex arithmetic
- Variability dimensioned arrays
- IEEE issues including infinity and NaN handling
- Exception handling
- Support for parallel processing
- Syntax for array/matrix operations.

8.2.4 COBOL Programming Language

This programming language, which is primarily used for business applications, is an ANSI (X3.23-1985) standard that was also adopted in 1985 by ISO (ISO 1989). On 18 March 1986, it was adopted by the United States as FIPS 21-2. A revision of ANSI X3.23 is currently in the planning stages. Public review began in 1990 with approval expected about 1999. An addendum to ANSI X3.23 for intrinsic functions (ANSI X3.23A-1989) was recently approved, and a Correction Addendum to ISO 1989 (*Programming Language COBOL*) is currently out for public review. The X3J4 Accredited Standards Committee on COBOL has recently received approval to work on an Addendum for Multi-Octet Character Sets that are necessary for Asian languages. It is also working on a COBOL Interface to the Forms Interface Management System (FIMS) (ANS Project 0676-D). Object-oriented extensions to COBOL are also under consideration by the committee. Despite standardization, non-standard versions of COBOL exist which can pose interoperability problems.

8.2.5 FORTRAN Programming Language

In 1978, ANSI promulgated a standard for FORTRAN (ANSI X3.9), a programming language for scientific numerical computation that has wide use and many variations. In 1980 this standard was endorsed by ISO (ISO 1539). FIPS 69 adopted X3.9-1978 on 4 September 1980 as a U.S. standard to promote portability of FORTRAN programs for use on a variety of data processing systems. The most recent FIPS (FIPS 69-1) was issued on 24 December 1985; a revised ANSI standard was issued in 1989. An ASC X3J3 project X3.198 (DIS 1539.2) is underway to produce an extended version of FORTRAN. Like COBOL, non-standard versions of FORTRAN exist, posing potential interoperability problems.

8.2.6 LISP Programming Language

LISP is currently the most popular computer language used in artificial intelligence (AI) programming in the United States, although Prolog standardization efforts are underway in the United Kingdom. LISP is designed for supporting symbolic manipulation and the interactive, trial-and-error style of programming employed by many AI researchers. It was invented in 1958 and has many dialects. The dialects tend to fall into one of two main camps: INTERLISP and MACLISP. In the interest of standardization, Common LISP was developed [Steele 1984]. It is not yet an official standard, but was created at the initiative of many vendors and is increasingly becoming the preferred version. Common

LISP compilers exist for several mainframe computers [Schutzer 1987], minicomputers, and microcomputers. The ANSI Standards Committee X3J13 is working on an ANSI standard for Common LISP. Currently, a full draft is under review by the X3J13 committee, and a public review is expected by the end of 1991. Except for efforts to standardize Scheme (IEEE 1178, which was approved on December 6, 1990) and the AI programming language Prolog, there are currently no other standards for knowledge-based specifications or notations.

8.2.7 BASIC Programming Language

BASIC is distinguished from other programming languages in its concern for the unsophisticated or novice user. While BASIC is a general-purpose programming language, it is designed primarily to be easy to learn, easy to use, and easy to remember. It is oriented toward, but not restricted to, interactive use. Its constructions are kept simple and special rules are kept to a minimum. The ANSI standard for Minimal BASIC (X3.60) was promulgated by ANSI in 1978 and adopted as FIPS 68 in 1980. It was subsequently adopted by ISO in 1984 (ISO 6373). In 1987, ANSI withdrew X3.60-1978 and superseded it with a standard for Full BASIC (X3.113-1987), which was adopted as FIPS 68-2 on 28 August 1987. This revision reflects major changes, improvements, and additions to the BASIC specification. In December 1989 ANSI issued the standard ANSI X3.113A, *Addendum to Programming Language Full BASIC, Modules, and Individual Character Input.*

8.3 Standards for Software Environments

8.3.1 Bindings

In addition to programming language standards, several standards provide interfaces or connectivity between programming languages and applications. Such "bindings" as they are called exist or are being proposed for the POSIX (IEEE P1003), GKS (ISO 7942), GKS-3D (ISO 8805), PHIGS (ISO 9592), and CGI (ISO 9636) standards.

POSIX bindings are planned for Ada, C, and FORTRAN. The PAR for IEEE project P1003.5, *Ada Bindings for POSIX*, was approved in December 1987, but a target date has not been established. The PAR for the FORTRAN binding (P1003.9) was approved in February 1989. A PAR has not yet been approved for the C binding (P1003.X).

ANSI and ISO have approved standards for FORTRAN, Pascal, and Ada bindings for GKS. The C binding is currently in the working draft stage. They are:

- ISO 8651-1, *FORTRAN Binding* (ANSI X3.124.1-1985), October 1988
- ISO 8651-2, *Pascal Binding* (ANSI X3.124.2-1985), October 1988
- ISO 8651-3, *Ada Binding* (ANSI X3.124.3-1985), October 1988
- DIS 8651-4, *C Binding* (ANSI X3.124.4-199x).

ISO draft standards have been developed for GKS-3D bindings for FORTRAN, Ada, and C. Pascal and LISP bindings are under development. They are:

- DIS 8806-1, *FORTRAN Binding*
- DIS 8806-3, *Ada Binding*
- DIS 8806-4, *C Binding*
- *Pascal Binding* [SC24 N 190] (ANS Project 0545-I)
- *LISP Binding* (ANS Project X3.122.5-199x, estimated completion 1991).

There are ISO standards for Ada and FORTRAN bindings to PHIGS. The Pascal and C bindings are awaiting balloting. All are draft ANSI standards. They are:

- ISO 9593-1, *FORTRAN Binding* (ASC X3.144.1-199x), October 1988
- DIS 9593-2, *Pascal Binding* (ASC X3.144.2-199x)
- ISO 9593-3, *Ada Binding* (ASC X3.144.3-199x), March 1990
- DIS 9593-4, *C Binding* (ASC X3.144.4-199x).

The FORTRAN and C bindings to CGI are currently ISO working documents and ANSI projects:

- WD 9636-8, *FORTRAN Binding* (ANS 0560-D)
- WD 9636-11, *C Binding* (ANS 0559-D).

ISO/IEC JTC1/SC22/WG11, *Binding Techniques for Languages* has several projects underway, some of which are broader in scope than the name of the WG suggests The following work items have been assigned to SC22/WG11 [SC21 N 5682 1991]:

- PDTR 10182, *Binding Techniques for Programming Languages* [SC22/WG11 N 754] -- The scope of this technical report is to classify language binding methods, report on particular instances in detail, and produce suggested guidelines for future language binding standards.

- *Specification for a Model for Common Language-Independent Procedure Calling Mechanisms (CLIPCM or CLIP)* [SC22/WG22 N 194R] -- This project intends to specify a generic way for referencing procedures. A draft was circulated among SC22 member bodies for registration as a CD document in February 1991.
- *Specification for a Set of Common Language-Independent Data Types (CLID)* [SC22/WG11 N 190] -- This project aims at a generic standard that would provide a reference collection of data types that can be used as common ground for actual programming languages. Draft 4 is currently circulating in SC22 for registration as a CD.
- DIS 10967, *Language Compatible Arithmetic Standard (LCAS)* [ISO/IEC JTC1/SC22 N 796] -- This standard, which specifies the essential properties of integer and floating point numbers that can be relied upon in writing portable software, is currently undergoing public review. A new work item proposal is underway to cover, in addition, complex arithmetic and mathematical procedures.

Bindings for fourth generation languages (4GLs), however, have yet to be standardized. This could pose a problem if 4GLs were used for database queries.

8.3.2 Software Engineering Environments

Another software engineering environment standardization project in addition to the CAIS-A project is the PCTE. Other projects standardize the interfaces between tools which might be combined to create an environment. Of particular interest are CASE tools.

The PCTE project was begun in 1983 by the Commission of the European Communities (CEC) European Strategic Programme for Research in Information Technology (ESPRIT). It is now being considered by ECMA Technical Committee 33 and is expected to be submitted to ISO for balloting as an international standard [PCTE 1989] in 1991. The ECMA PCTE abstract was completed in September 1990 with formal approval in December 1990 [Davis 1990].

The goal of the PCTE project was to describe and prototype tool interfaces that could be used to define a software development environment. The environment would comprise a set of public tool interfaces (PTIs) as well as a data management system. As defined by the PCTE project, a PTI is a non-proprietary interface existing as a library unit that may be used by a tool to provide access to system services. Tool builders might use the interfaces to either integrate or attach their tool products to an environment. The distinction between integration and attachment reflects the degree to which the environment

monitors, controls, and makes use of the information on a given tool. An integrated tool makes full use of the services provided by the environment such as logging an audit trail and data management. An attached tool does not. For example, data are maintained in a repository known only to that tool.

The criteria for development of the PCTE were that it be policy and mechanism independent, support a distributed environment, provide easy tool integration, provide a complete interface definition, and provide multi-language support. To accomplish this, PCTE defines the services needed by the tools. The services provided by PCTE include data management, tool execution and communication, distribution and environment management, and programmer interface for user interface management.

The NATO Independent European Programme Group (IEPG) TA-13 is responsible for managing the evolution of PCTE to a standard tool interface for civil and defense use [Dowling 1988]. This language independent tool interface is called PCTE+. It offers the following extensions to the facilities provided by PCTE:

- Composite entities
- Version support
- Security
- The process as an object
- The metabase
- Multiple inheritance of entity type definitions
- Type definition modes
- Notification of specified object accesses
- Accounting
- Real and enumeration attribute types.

In addition to these extensions, constraints existing in PCTE as a result of its aim for compatibility with UNIX have been removed. Issue 3 of PCTE+ (upon which the ECMA standard is based) contains an abstract specification with bindings for C and Ada.

The Portable Common Tools Interface Set (PCIS) effort is aimed at converging CAIS-A and PCTE+. This effort may result in the best of both standards and shift consensus to the jointly developed interface.

Among the other work being done in this area is an IEEE Computer Society Project (P1209) for a *Recommended Practice for Evaluating CASE Tools.* The PAR was

approved on 1 June 1989. The IEEE Committee has met four times and has published a draft that is still not stable. Balloting is expected within 2 years.

The Institution of Electrical Engineers (IEE)/British Computer Society Joint Working Party on Software Engineering Standards has also discussed the possibility of investigating CASE tools, in particular, the way in which their use supports conformance to high quality standards. However, their only planned activity is to comment on IEEE P1209. In discussions related to a proposed U.K. MoD standard (DEF-STAN-00-55), *Requirements for the Procurement of Safety Critical Software,* the remark has been made that currently available CASE tools would not meet their requirements, since none of the tools have been or can be subject to the kind of formal methods analysis laid down in the proposal [Kemp 1990].

Another issue with respect to tools and toolsets is the ability to interconnect tools from different software developers. Consequently, the IEEE Computer Society approved a PAR for a *Standard for Interconnections Among Computing System Engineering Tools* (P1175) in February 1988. The core of this standard is the Standard Text Language (STL), which describes concepts such as data, conditions, events, and states, as well as transformation, control-transition, and state-transition operations. The proposed standard supports both textual and graphical forms [P1175 1989]. It is currently in the final stages before IEEE balloting as a trial-use standard.

The CASE Integration Services (CIS) Committee is also trying to provide direction for integration standards in the CASE arena. Originally formed to discuss a standard interface for services to assist in the integration of software engineering tools into CASE environments, the CIS committee is now a public forum with many organizations participating in its deliberations and others monitoring the process as observers. The CIS committee has chosen to focus on two areas: (1) data integration, the sharing of meta-data among tools, and, (2) control integration, the sharing of control information among tools.

A standard known as ATIS (Atherton Tools Integration Services, or alternatively, A Tools Integration Standard) [CIS 1990] which was developed jointly by Digital Equipment Corporation and Atherton Technology, was proposed as a Base Document for the CIS work and is under review by committee members. ATIS is based on the object-oriented interfaces in Atherton Technology's Software BackPlane product. While it addresses many of the integration issues, it does so as a monolithic solution and has several deficiencies. However, the general solution offered by ATIS, (i.e., an object-oriented approach based on defined and extensible schema and methods) is considered by CIS members to be the

preferred approach to providing integration services. Thus ATIS can provide a starting point for the ongoing work of CIS [Nolan 1990]. At CIS's request, ANSI is considering making CIS a group to pursue this standards issue.

Another standardization activity in this area is the CASE Data Interchange Format (CDIF) effort. The CDIF Technical Committee operates under the authority of the Electronic Industries Association (EIA), and its charter is "to develop an ANSI standard (eventually to become an ISO standard) for the exchange of information between CASEs." Three releases of standards are planned: a framework standard, a syntax standard, and a semantic standard. Their EIA Project Numbers (PNs) are 2387, 2389, and 2329, respectively. The Committee plans to publish the standards as interim standards in the summer or fall of 1991 [Ornstern 1991]. Both CALS and P1175 representatives have participated in the meetings.

8.3.3 Knowledge-Based Systems (KBS)

Areas where standards are lacking, probably due to technological immaturity, include knowledge-based systems (KBS), and software repositories. There are no standards for knowledge exchange, knowledge management or development of knowledge bases for life-cycle maintainability. Several standards exist or are under development in the areas of software process models and development methods.

The U.K. General Expert System Methods Initiative (GEMINI) is an example of a project that is addressing needs for knowledge-based standards. In mid-1988, the CCTA launched this project to lay the foundation for a systematic KBS development methodology. A feasibility study concluded that there is strong support for such a method and that its development is both timely and feasible [Montgomery et al. 1989].

On March 21, 1991, the IEEE Standards Board approved a PAR for the development of a *Standard for an Architecture for Knowledge Representation*. The IEEE Project number is P1252 [P1252 1991]. This is a broader issue than KBS, development methods or tools.

An important method of integrating KBS is by means of the IRDS (ISO 10027). The first area of standardization for expert systems will likely be bindings between expert systems and programming languages, databases, and user interfaces. Progress towards providing decision support and decision making tools and methods is slow but may be stimulated by the early release of the IBM Repository [MODITSB 1989].

ASC X3, Information Processing Systems recently announced a development project for *IRDS Extensions to Support CASE Environment for Information Interchange*. This standard would define an IRDS, based on ANS X3.138-1988, capable of supporting the full range of IRDS applications. In particular, it would be capable of acting as the IRD in a traditional data processing environment and capable of providing the stable store necessary to support an integrated CASE environment. The standard wold include both the semantics of the IRDS and a software interface suitable to the needs of active CASE and Dictionary tools. The development has been assigned to Technical Committee X3H4.2 [X3 1990].

8.3.4 Software Repositories and Reuse

Software repository standards to facilitate software reuse do not yet exist. These might include library structure, cataloging scheme, retrieval, documentation and maintenance, validation and verification, and reuse policy and guidance standards. Reuse is a strategy with potential to increase software productivity, reliability, and quality.

8.3.5 Process Models and Development Methods

A model of the software development process is the ordered sequence of activities that occur during the course of software development. Examples of software development process models include the waterfall method, rapid prototyping, and the spiral model. By contrast, a software development method (methodology) is the way the specific development activities are actually carried out by the developer. An example is the object-oriented approach.

There is currently a single U.S. standard, DoD-STD-2167A, *Defense Software Development Standard*, for the process of software development. It superseded DoD-STD-2167, which was tied to the waterfall method and did not easily allow tailoring to other methods. The IEEE has a project underway (IEEE P1074), *Standard for Software Life Cycle Processes*, which will define the processes of the software life cycle and describe the activities required to develop or maintain software in accordance with existing IEEE standards.

The IEEE publishes a volume of Software Engineering Standards [IEEE 1983] comprising 17 standards developed for software engineering. Most of the standards are ANSI/IEEE standards and they provide recommendations reflecting the state of the art in

the application of engineering principles to the development and maintenance of software. The 17 standards are:

1. ANSI/IEEE Std. 610.12 - *IEEE Standard Glossary of Software Engineering Terminology*, 1990
2. ANSI/IEEE Std. 730 - *IEEE Standard for Software Quality Assurance Plans*, 1984
3. ANSI/IEEE Std. 828 - *IEEE Standard for Software Configuration Management Plans*, 1983
4. ANSI/IEEE Std. 829 - *IEEE Standard for Software Test Documentation*, 1983
5. ANSI/IEEE Std. 830 - *IEEE Guide to Software Requirements Specifications*, 1984
6. IEEE Std. 928.1 - *IEEE Standard Dictionary of Measures to Produce Reliable Software*, 1988
7. IEEE Std.928.2 - *IEEE Guide for the Use of IEEE Standard Dictionary of Measures to Produce Reliable Software*, 1988
8. ANSI/IEEE Std. 983 - *IEEE Guide for Software Quality Assurance Planning*, 1986
9. ANSI/IEEE Std. 990 - *IEEE Recommended Practice for Ada as a Program Design Language*, 1986
10. ANSI/IEEE Std. 1002 - *IEEE Standard Taxonomy for Software Engineering Standards*, 1987
11. ANSI/IEEE Std. 1008 - *IEEE Standard for Software Unit Testing*, 1987
12. ANSI/IEEE Std. 1012 - *IEEE Standard for Software Verification and Validation Plans*, 1987
13. ANSI/IEEE Std. 1016 - *IEEE Recommended Practice for Software Design Descriptions*, 1987
14. IEEE Std. 1028 - *IEEE Standard for Software Reviews and Audits*, 1988
15. ANSI/IEEE Std. 1042 - *IEEE Guide to Software Configuration Management*, 1988
16. ANSI/IEEE Std. 1058.1 - *IEEE Standard for Software Project Management Plans*, 1987
17. ANSI/IEEE Std. 1063 - *IEEE Standard for Software User Documentation*, 1989.

Standards under development in this series include:

- IEEE P1016.2 *·Guide to Software Design Descriptions*
- IEEE P1044 *Classification of Software Errors, Faults, and Failures*
- IEEE P1045 *Software Productivity Metrics*
- IEEE P1059 *Software Verification and Validation*
- IEEE P1061 *Software Quality Metrics Methodology*
- IEEE P1062 *Software Acquisition*
- IEEE P1074 *Software Life Cycle Processes*
- IEEE P1219 *Software Maintenance Standard*
- IEEE P1228 *Software Safety Plans.*

Development of international software engineering standards by ISO/IEC JTC1 SC7 on Software Engineering is still in its early stages. The emphasis for the next 3 years will be on establishing a foundation on which to build future standards. The following standards projects are underway in SC7's four working groups [Edelstein et al. 1991]:

- WG1 - Symbols, charts, and diagrams
  - Conceptual framework for software development diagrams
  - Charting techniques for software development and maintenance
  - Conventions for use of symbols and icons in software systems
  - Transfer of information between life cycle phases
- WG2 - Software system documentation
  - Guidelines for documentation of computer-based systems
- WG3 - Software engineering and quality management
  - Software quality characteristics
  - Software configuration management
  - Software life cycle management
  - Software quality management
  - Requirements/design/testing, etc.
  - Evaluation and selection of CASE tools
- WG5 - Reference model for software development
  - Reference model
  - Reference model overview

- Reference model -- mapping of relevant information systems engineering standards.

International activity that will affect software development is the standardization of quality management systems. ISO 9001 represents a concise, generic description of the essential elements of management systems for assuring quality in development, production, and qualification with emphasis on the "what" over the "how." ISO 9001, Part 3: *Guidelines for the Application of ISO 9001 to the Development, Supply and Maintenance of Software*, was approved by international ballot and adopted by TC 176 in November 1990 [Edelstein et al. 1991].

There are currently no standards specifically for the development of expert systems. It is not clear that the development of expert systems will need to follow a different or unique process model.

The ESPRIT project "accueil de logiciel futur" aims to provide a knowledge-assisted software process model on top of the PCTE [Brettnacher et al. 1988].

Development methods tend to be proprietary and not subject to standardization. However, one IEEE project (P1152), *Standard for Object Oriented Programming Language and Environment,* is developing a standard based on the SmallTalk programming language and environment.

8.4 Assessment of Coverage by Standards

There are international standards for most, but not all, of the commonly used programming services. Although ISO and the U.S. Government have adopted ANSI X3.159, Programming Language C, there are potential compatibility problems between C and C++. Moreover, even though COBOL is an ANSI and ISO standard, many non-standard versions of it and extensions to it exist, creating interoperability problems. The other standards are stable. However, Ada is undergoing a revision process and some aspects of the current language may not be upwardly compatible with its successor, Ada 9X.

There is no standard set of guidelines for using the features of the Ada programming language; without guidance, applications written in Ada may have unpredictable portability. This issue was addressed in a separate WAM paper, *An Assessment of Portability and Reuse*.

Bindings between Ada and special-purpose languages (such as 4GLs) may be required for WAM.

Standards have not been developed for languages used for certain technologies and application areas. If applicable to WAM, these areas might include languages used in artificial intelligence (standards for LISP and Prolog have been developed but not for other languages) and used for interfaces to specific COTS/NDI software. LISP is more popular in the U.S. while Prolog is more popular in U.K. and Europe, posing potential interoperability problems.

Standards for software development environments, including CASE tools and environments, are in the early phases of development. Some are currently restricted to interfaces between tools while others address entire environments. The extent to which environments such as PCTE and CAIS can evolve and be tailored is unknown. Moreover, CAIS is already suffering from a dearth of conforming commercial products. Tool interfaces based on commercial products may lack flexibility. Standards for KBS do not exist. Software repository standards to facilitate reuse do not yet exist. This could have an adverse effect on a COTS/NDI acquisition strategy by making NDI software difficult to identify.

Software engineering standards that address the software development process and development methods, and ultimately software quality, are in the early phases of the international standardization process. It will be at least 3 years before a foundation for these standards is established. To date, none address the development of expert systems.

9. SECURITY AND OSI SYSTEM MANAGEMENT STANDARDS

This chapter summarizes the status of standards in five areas: security, network (OSI) management, registration authorities, conformance testing, and formal description techniques (FDTs). Appendix F identifies organizations and standards bodies that have contributed to development of these standards.

9.1 Requirements for Security and OSI Management Services

Security services protect the components, mechanisms, and information of the CCIS. Basic security features include authentication, access control, confidentiality, integrity, and non-repudiation. OSI management addresses fault management, configuration management, accounting management, performance management, and security management.

Standards for security and OSI management are described first (Sections 9.2 and 9.3, respectively). These are followed by standards for conformance testing (Section 9.4) and registration authorities (Section 9.5). FDTs are addressed with conformance testing standards in Section 9.5.

9.2 Status of Standards for Security

Security features are required by both civil and military systems and may be expected to be addressed by ISO and CCITT standards in the future. Specific military requirements for security and the TSGCE recommendations for addressing these requirements are treated in Appendix K.

9.2.1 Overview of Civil and Military Security Standards

Standards for security are being addressed in the following:

- ISO 7498-2, *Security Architecture,* February 1989.
- DIS 10181, *Security Frameworks in Open Systems,* December 1989.
- *NATO OSI Security Architecture (NOSA),* March 1988, UNCLASSIFIED [NOSA 1988], defines the security services, based upon ISO 7498-2, required in the NATO OSI Reference Model.
- *Security Architecture for NATO Information Systems Interconnection (SANISI),* Version 2.0, April 1989, NATO CONFIDENTIAL [SANISI 1989]. SANISI is planned to be standardized as STANAG 4250-2.

- Security annexes (Annex B) for NATO OSI STANAGs 4250-56 and 4261-66 and other STANAGs planned for Layers 6 and 7 (a draft Annex B has been prepared for STANAG 4253 and 4263).
- A series of appendixes to SANISI are expected to be developed to expand on the actual implementation of a secure protocol. The first of these, Trusted Communications Sublayer (TCS), is defined in the NOSA and SANISI documents.
- Secure Data Network System (SDNS) security protocols for the network and Transport Layer. (There is a close correspondence of services between the Layer 3 SDNS security protocol and TCS [PC 1989].)
- Extensions to SDNS protocols, such as the End-to-End Security Protocol (EESP) being developed in the United Kingdom for submission to ISO SC21/WG1.
- IEEE P1003.6 and JTC1 SC22 standards for POSIX security (see Sections 7.2.1 and 9.2.2.12).

9.2.2 Security Standards Work in ISO[30]

JTC1 SC21/WG1, WG3, and WG6 have begun a number of initiatives to address the models and standards frameworks required to progress OSI security standards. These include:

- Management plan for security [SC21 SD-7]
- OSI security architecture (ISO 7498-2)
- Guide to Open Systems Security [SC21 N 6167, July 1991]
- Security framework overview (WD 10181-1)
- Authentication framework (DIS 10181-2)
- Access control framework (CD 10181-3)
- Non-repudiation framework (WD 10181-4)
- Confidentiality framework (WD 10181-5)
- Integrity framework (WD 10181-6)
- Security audit trail function (CD 10181-7)
- Key management (WD 10181-8)
- Upper layer security model [CD 10745, SC21 N 6095; June 1991].

[30] Discussion taken from *Work on Security within IST/21*, SC21 N 5757, March 1991.

Other SC 21 work is progressing on security enhancements to presentation standards, to association control standards, and (as necessary) to other Application Layer standards:

- Reference model of data management (DIS 10032)
- RDA (DIS 9579)
- Systems management tutorial (ISO 10040)
- Security alarm reporting function (ISO 10164-7)
- Objects and attributes for access control (CD 10164-9.2)
- CMIS access control (ISO 9595/PDAM 4)
- CMIP access control (planned amendment to ISO 9596-1)
- Directory access control (ISO 9594-1/PDAM 1, ISO 9594-2/PDAM 1, ISO 9594-3/PDAM 1, and ISO 9594-4/PDAM 1)
- Directory authentication access control (ISO 9594-8/PDAM 1)
- FTAM security services (new work item JTC1 N955, amendment to ISO 8571)
- TP security (new work item SC21 N 5176, amendments to DIS 10026-1, 10026-2, and 10026-3)
- Security Exchange ASE service and protocol (SC21 N 6096, 6097, 6098)
- ACSE authentication (ISO 8649/AM 1)
- Conditions for ACSE authentication (new work item proposed in JTC1/SC10 and transferred to SC20)
- Presentation confidentiality and integrity (SC21 N 5059)
- Presentation cryptographic techniques (transferred from SC20 WG3)
- ODP security (SC21 N 4888)
- Authentication services for distributed applications (SC21 N 6099)
- ASN.1 encoding rules to provide upper layer security and compression (SC21 N 6130).

9.2.2.1 Security Framework

DIS 10181, *Open Systems Security Framework,* defines the framework within which security services for open systems are specified. These open systems include database, distributed applications, ODP, and OSI. The framework addresses data elements and sequences of operations (but not protocol elements) that are used to obtain security

services. These security services may apply to the communicating entities of systems as well as to data exchanged between systems and to data managed by systems. Note that the security framework is being developed by SC21/WG1, whereas the Upper Layer Security Model is the responsibility of SC21/WG6 and the Lower Layer Security Model is the responsibility of SC6/WG2 and WG4. Table 21 identifies the scope of the individual parts of the framework.

Table 21. OSI Security Framework--DIS 10181

• Part 1 (WD 10181-1), *Overview*, 3 January 1990 [SC21 N 5532]--Describes the organization of the security framework, defines security concepts that are required in more than one part of the security framework, and describes the interrelationship of the services and mechanisms identified in other parts of the framework. CD expected June 1992.
• Part 2 (DIS 10181-2), *Authentication Framework*,--Authentication is the process of corroborating an identity. Overlap with DIS 9798-1, Security Techniques, Part 1: Entity Authentication Mechanisms. SC27 proposed a joint meeting to align terminology and concepts relating to authentication during January - March 1991. Voting began 18 July 1991. IS expected March 1992.
• Part 3 (CD 10181-3), *Access Control Framework,June 1991*--Access control is the process of determining whether the use of resources within an open system is permitted. DIS expected March 1992.
• Part 4 (WD 10181-4), *Non-Repudiation Framework*, December 1989 [SC21 N 4209]--Non-repudiation is a security service that provides proof of origin or delivery of data in order to protect the sender against the false denial by the recipient, that the data has been received, or to protect the recipient against false denial by the sender that the data has been sent. The use of appropriate mechanisms is coupled with the necessary assurance mechanisms providing proof about certain properties of the communications between the entities involved, such as its integrity, origin, time, and destination. Non-repudiation implies the existence of an agreed third party whose primary role is to arbitrate disputes resulting from non-repudiation. CD status expected in June 1992.
• Part 5 (WD 10181-5), *Confidentiality Framework*, December 1989 [SC21 N 5530] - The maintenance of the secrecy of data is called confidentiality. CD expected June 1992.
• Part 6 (WD 10181-6), *Integrity Framework*, 3 January 1990 [SC21 N 5531]--The integrity framework addresses the constancy of a data value and not any other form of invariant that such a value may possess. In particular, it does not address the constancy of any information that the data is deemed to represent. There are two types of integrity mechanisms needed for two types of constancy. The first is the constancy of the value of data in an environment in which a *random* modification to integral data may be made. The second is the constancy of the value of data in an environment in which a modification to integral data may *deliberately* be made to defeat the integrity mechanism. CD status expected in June 1992.
• Part 7 (CD 10181-7), *Security Audit Framework*, June 1991. This CD describes a model of a system's audit trail, a description of audit events and the different types of information involved, and its relationship to management activities. DIS expected March 1992.
• Part 8 (WD 10181-8), *Key Management*. Work on this part is being carried out in SC27. The liaison statement is in SC21 N 5578.

9.2.2.2 Security Models[31]

The purpose of the security models is to apply the security concepts detailed in the Security Frameworks to specific areas of open systems architectures.

[31] Discussion for this section taken from *Guide to Open Systems Security*, SC21 N 5533, 3 January 1991.

9.2.2.2.1 Upper Layer Security Model

The Upper Layer Security Model is intended to provide the necessary basis for the development of security-related protocol elements for the secure exchange of information between open systems, with the interchange of information related to security policy control and management, and with services and mechanisms for controlling access to resources accessible via OSI. It will address the following:

- Security aspects of communication in the upper layers of OSI
- Relationships between security services and mechanisms in the upper layers, to be considered in greater detail than is provided in ISO 7498-2
- Properties of the possible combinations of security services and mechanisms in the upper layers
- Interactions among Application, Presentation, and Session Layers in providing security services
- Invocation of lower layer security services
- Requirements for security management in the upper layers.

The Upper Layer Security Model [SC21 N 6095] progressed to CD status [CD 10745] in June 1991. Associated projects include:

- Service and protocol for security application service element [SC21 N 4110, proposal for NWI, January 1990]--name changed from Authentication Exchange ASE to Security ASE; CD expected June 1992
- Presentation cryptographic techniques (project transferred from SC20)
- Practical conditions for ACSE authentication (project transferred from SC20).

9.2.2.2.2 Lower Layer Security Model

The purpose of this standard is to provide standards developers with the necessary basis for the development of security-related protocol and security-related protocol elements appropriate to the lower layers of the OSI Basic Reference Model. The model addresses:

- The concepts that are generally applicable to the lower layer protocols
- General guidelines for the selection and placement of security services and mechanisms
- Interactions between the layers--both within the lower layers and between the upper and lower layers--relating to security
- General requirements for security management across the lower layers.

The relevant standards are:

- *Lower Layer Security Guidelines* [SC6 N 6227], early WD stage
- *Transport Layer Security Protocol* [SC6 N 6285], early WD stage
- *Network Layer Security Protocol* [SC6 N 6221; JTC1 N 666], early WD stage.

The Network Layer Security Protocol os based on three standards efforts. One part of the U.S. Secure Data Network System (SDNS) is a connectionless Layer 3 security protocol (see Section 9.2.4.1) equivalent to the end-to-end encryption portion of the Trusted Communications Sublayer (TCS). Northern Telecom's SPX security protocol adds connection-oriented service to SP3. The United Kingdom's End-to-End Security Protocol (EESP) adds connection-oriented services to SP3 and includes integrity and traffic padding. EESP was introduced into SC21/WG-1 during May 1990 and has been proposed to the JTC1 as a new work item. EESP may require changes to ISO 8648, *Internal Organization of the Network Layer* [BSI 1989].

While an OSI Lower Layer Security Model [SC6 N 5333] was begun, it was decided at a joint meeting of SC6, WG2 and WG4 in October 1990 not to progress it. However, the guidelines document may form the basis of a future standard [SC6 N 6219 1990].

9.2.2.3 Requirements and Approaches for Security

In March 1990 at the Workshop on Distributed Applications in Phoenix, the following observations on security were made [SC21 N 4526 1990]:

- It is highly desirable to standardize a general approach to providing security in the Application Layer. This can be accomplished by supporting a variety of security methods that involve communication of security information. Examples of such methods could be:
  - Two-way or three-way authentication exchange
  - Privilege attribute certificate transfer
  - Key negotiation sequence.
- A security method would consist of semantics, syntax, and procedural rules relating to the communications aspects of the method.
- There appear to be three possible OSI architectural approaches to supporting security methods:

- No generic security ASE(s), in which the syntax and procedural rules for any security method are imported into the specification of an application-specific ASE.
- One generic ASE, in which one ASE is provided that can import into its abstract syntax the syntax of any security method. Possibly, the procedural rules associated with all security methods could be incorporated into the ASE specification.
- Multiple purpose-specific security ASEs, in which each ASE incorporates the procedural rules and syntax for a particular security method or group of closely related methods (e.g., an ASE to support two-way authentication exchanges).

• Satisfaction of security requirements of TP, Directory, and OSI Management will depend on addressing security modelling issues related to distributed applications. The Upper Layer Security Model includes this in its scope, but the current draft of the model suggests little will be done in this area when it is first released.

• Access control to data resources must address the data model being used by individual applications such as DFR, DTAM, FTAM, IRDS, etc. Use of a common data modelling approach provides the potential for use of common access control facilities to such data resources and consequently increases the attractiveness of the common data model approach in order to prevent the need for re-specification of access control facilities for data management applications.

9.2.2.4 FTAM Security

Most FTAM security appears to be based around access control lists, such as listing "people" and "groups of people" that are or are not allowed access. JTC1 N 955, *Enhancements to FTAM Security Services,* is a new work item proposing amendment (WDAM 4) to several parts of ISO 8571 (FTAM) to deal with authentication and access control in FTAM and suggests some specific forms of access control mechanism [SC21 N 5757 1991].

9.2.2.5 TP Security

SC21 N 5176, *OSITP Security,* is a new work item for Transaction Processing security. It proposes amendments to DIS 10026 (Parts 1,2, and 3) addressing the formulation and provision of mechanisms to meet a number of security services, including authentication, access control, confidentiality, integrity, non-repudiation, auditing, "management," access right revocation, replay protection, prevention of the denial of service, reliability, and traffic flow confidentiality. This is to deal both with control of access to TP resources and to TP application entities [SC21 N 5757 1991].

9.2.2.6 ODA Security

Changes are being made to ODA, ISO 8613, to improve the security aspects. ODA provides protection for documents as a whole or for parts of a document. Confidentiality, integrity, authentication, and non-repudiation of origin are all supported using encipherment, fingerprints, and seals [SC21 N 4472 1990].

9.2.2.7 Directory Security

ISO 9594-1 (The Directory) PDAM 1, ISO 9594-2 PDAM 1, ISO 9594-3 PDAM 1, and ISO 9594-4 PDAM 1 develop a model for access control and an access control scheme for general use (in Part 2) and (in Parts 3 and 4) provides "hooks" whereby the access to directory information can be controlled (not to the entities holding the information). These hooks inserted by the amendments to Parts 3 and 4 allow a variety of external access control schemes to be used, not necessarily the basic access control scheme of Part 2 [SC21 N 5757 1991]. A new work item, *Security Enchantment to Directory*, will extend Part 8 [SC21 N 6172, July 1991].

9.2.2.8 Database Security

SQL2 specifies some security functionality but the standard (ISO 9075) does not address how a secure database should be built. Since the security of the operating system needs to be considered in building a (secure) database, POSIX standards are also relevant to the security of databases.

9.2.2.9 International Standardized Profile (ISP) Security

It has been suggested that the scope of TR 10000 be extended to address security feature in ISPs. An ISP may contain security features if one (or more) of the base standards to which it refers contain security features. In general, the specification of an ISP having security features has two distinct parts, one concerned with security-related functions and one concerned with other functions. This specification is referred to as a security sub-profile. An ISP may contain one (or more) security sub-profiles. The security sub-profile comprises [Humphreys 1991]:

- A description of the target system environment in which the sub-profile is intended to be used
- An identification of the range of (security) threats that the sub-profile is intended to counter in the target system environment

- A specification of how security functions in base standards should be used to counter the assumed threats
- A specification of the security mechanisms that should be used to provide the necessary security functions (where the base standards provide some freedom of choice)
- A specification of the range of the realizable quality attainable through the use of this sub-profile.

9.2.2.10 Proposed ASE for Security

CCITT SG VII has identified a need to define an ASE capable of providing arbitrarily complex n-way security exchanges, where such exchanges could occur in conjunction with association establishment or after an association has been established. The SG VIII proposal [SC21 N 3991 1989] identifies such Application Layer exchanges as peer-entity authentication exchanges, exchanges of keying information, and combinations of these. The proposed Security Exchange Service Element would address ACSE shortcomings: peer authentication in ACSE (ISO 8649 DAD1) applies only at the time of association establishment and is limited to a single two-way exchange.

9.2.2.11 Security Exchange Information

SC21 has adopted a new work item on security exchange ASE that will provide for the transfer of information between a pair of application-entity invocations in support of security services such as authentication, access control, confidentiality, and integrity. The security exchange would be allowed to occur either in conjunction with association establishment or at any time on an established association. Encryption/signature functions could be located in either the Application Layer or the Presentation Layer. A standard method for defining security exchange information using ASN.1 will be defined as part of this work item [SC21 N 5002 1990]. The Generic Security Exchange ASE standard will comprise four parts, three of which are being recommended for progression to CD status [SC21 N 5448 1990]:

- Security Exchange Model and Specification Framework, [SC21 N 6096] June 1991
- Security Exchange ASE Service Definition, [SC21 N 6097] June 1991
- Security Exchange ASE Protocol Specification, [SC21 N 6098] June 1991
- Security Exchange ASE PICS Proforma.

9.2.2.12 Additional Security Standards Work in ISO

JTC1 held a Workshop on Security in London during 5-7 November 1990. JTC1 participants from the Special Working Group (SWG) on Security, SWG-EDI, SC6 (WG2/WG4), SC17(WG4), SC18(WG1/WG4), SC21(WG1), SC22 (POSIX Security), and SC27 attended as well as additional participants are from TC68 and TC154. The topics offered for consideration at this workshop was wide ranging and indicate the scope of ongoing work and areas envisioned for standardization in the next 5 or more years [IST/21:2170 1990]:

- Information security technology
- Information security risk analysis methodology
- Access control to applications and or security objects (e.g., for confidentiality and integrity)
- User authentication
- Indirect access to security objects or delegation mechanisms
- Physical security in such areas as biometrics equipment, TEMPEST equipment, tamper resistance, computer room design, and card access control equipment
- Network security management
- Network access control
- Syntax and data elements for audit trails
- Secure version of OSI protocols (e.g., Data Link Layer, Transport Layer, upper layers)
- Secure versions of EDI
- Secure versions of standards for office documentation
- Standards for secure application design
- Secure versions of databases
- Generic security techniques and mechanisms in such areas as message authentication, digital signatures, peer entity authentication, and key management
- Security of distributed applications
- Security of transaction processing
- Information technology security evaluation criteria
- Integrated circuit cards security.

9.2.3 Security Standards Work in NATO

9.2.3.1 TSGCE SG9 AHWG on Security

The TSGCE SG9 Ad Hoc Working Group (AHWG) on Security is developing the NOSA and SANISI documents (identified in Section 9.2.1 above), whereas the security annexes for the layer STANAGs are the responsibility of TSGCE SG9 WG1 and WG2. NOSA was developed to give guidance to contractors and procurement managers on the preferred placement of security services within OSI-conformant systems. SANISI provides more detailed rationale on the placement of security services and mechanisms within the NATO OSI Reference Model. The emphasis has been to derive appropriate refinements and augmentations to ISO 7498-2 so that a comprehensive set of security facilities can be defined to satisfy the NATO secure interoperability requirements. SANISI is expected to remain classified for the foreseeable future. Annexes in SANISI are planned to address LANs, security management, and TCS services. There are some terminology differences between NOSA and SANISI; otherwise these documents are considered stable. The AHWG on Security has also developed a classification guide [NATO 1989a].

The TCS architecture has been broken down into five functional modules. A description of this internal architecture was presented at the SHAPE Technical Centre Military OSI Symposium in June 1990 [NATO 1990]. Two of the five TCS modules identified so far now have service definitions and protocol specifications in draft form [NATO 1990a]. *Work is continuing in the AHWG on Security to make the TCS conform to the eventual security protocol agreed by ISO--only the implementation would be unique to NATO.* Further, security issues have been identified by the AHWG on ISDN; when a security architecture is defined for ISDN, that architecture will be assessed to see how it relates to NOSA.

9.2.3.2 NOSA

NOSA identifies OSI security services for the Physical, Network, and Presentation/Application Layers. These are [NOSA 1988]:

- Physical Layer will provide two services by transparent means without requiring modifications to the Physical Layer protocols:
  - Connection confidentiality, which is capable of dealing with circumstances where the physical communication is intermittent or asymmetric.
  - Traffic flow confidentiality.

- Network Layer security services are provided within subnetwork-dependent roles and within a TCS:
  - Subnetwork-dependent services are peer entity authentication, data origin authentication, access control, connection confidentiality, connectionless confidentiality, traffic flow confidentiality, connection integrity without recovery, and connectionless integrity.
  - Security services that can be provided by the NATO TCS are identical to the eight identified above for subnetwork-dependent roles.
- Presentation/Application Layers could provide as many as 14 security services:
  - The eight services identified above for the Network Layer.
  - The following additional six services: selective field confidentiality, connection integrity with recovery, selective field connection integrity, selective field connectionless integrity, non-repudiation with proof of origin, and nonrepudiation with proof of delivery.

9.2.4 Other Security Standards Work

9.2.4.1 Secure Data Network System (SDNS)

The goals of SDNS are to create specifications for end-to-end security; to use the OSI Reference Model; to design an architecture to include electronic mail and end-to-end encryption; to provide transparent key management; and to demonstrate feasibility of techniques. The U.S. National Security Agency (NSA) is supporting the SDNS project [Tater et al. 1989], which has released to the public domain several standards for security protocols [NSA 1989; NSA 1989a; NSA 1989b; NSA 1989c; NSA 1989d; NSA 1989e; NSA 1989f; NSA 1989g; NSA 1989h; NSA 1989i; NSA 1989j]. The elements of SDNS are described in Table 22.

The SP3 protocol is comparable to the TCS requirement identified by TSGCE SG9. However, it does not meet all the TCS requirements and it requires CL network services. For example, traffic flow confidentiality is not supported by SDNS. The United Kingdom has recently introduced the EESP, which could address the TCS requirements more fully and support services for CO networks [Neve 1990]. There is some question as to whether the security models and the mechanisms that provide security services underlying SDNS and the TCS are so different that SDNS can meet the TCS requirements [Walmsley 1990].[32]

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[32] In a private communication with Clive Walmsley, RSRE, in March 1990, a comment was made that the prospect of interoperability between the two models would be remote.

Table 22. Security Protocols Developed In SDNS

- Security Protocol 3 (SP3). Provides various security services in the Network Layer through the use of cryptographic mechanisms; SP3 is a subnetwork independent convergence protocol (SNICP, ISO 8648) that extends the CLNS (ISO 8348/AD1) with confidentiality (protection against passive monitoring), integrity (protection against modification, replay, addition, or deletion), or both. SP3 is designed to be used at the top of Layer 3 [NSA 1989].
- Security Protocol 4 (SP4). Specifies optional extensions of the COTS (ISO 8072) and connectionless transport service (ISO 8072/AD1) for the Transport Layer. The extensions permit the use of cryptographic techniques to provide data protection for transport connections for connectionless-mode Transport Protocol Data Unit (TPDU) transmission. SP4 can be used with the CONS or the CLNS. SP4 is designed to be used at the bottom of Layer 4 [NSA 1989a].
- Message Security Protocol (MSP). Defines additions to the CCITT X.400 (either 1984 or 1988) that permit any type of message (including interpersonal messages) to be sent and received securely. When used with the conventions defined by ANSI for the X.400 Message Transfer System, MSP can be used to exchange EDI messages securely. The MSP provides writer-to-reader confidentiality, access control for message transfer, and request for a signed receipt of the received message. SDN 701 [NSA 1989c] specifies the MSP, and SDN 702 [NSA 1989d] defines new attribute types and object classes for inclusion in the X.500 Directory in support of key management functions used by MSP.
- Key Management Protocol. Key management provides for the generation, distribution, and updating of traffic encryption keys (TEKs). The abstract model for a Key Management Application Process (KMAP) consists of two parts: the information processing part that is supported by Management Information Bases (MIBs) for keys and for TEKs, and the communication part, called the Key Management Application Entity (KMAE). The KMAE consists of the Layer 7 ACSE (ISO 8649) and a Key Management Application Service Element (KMASE). The Key Management Protocol provides Layer 7 peer-level services between the KMASEs of two KMAPs. The Key Management Protocol assumes the use of the connection-oriented presentation services (ISO 8822) [NSA 1989b; NSA 1989h; NSA 1989i; NSA 1989j].
- Access Control. Access control is the prevention of the unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner (ISO 7498-2). SDN 801, SDN 802, and SDN 802/1 [NSA 1989e; NSA 1989f; NSA 1989g] specify an access control framework based on a four-tiered model and an Access Control Information System (ACIS) that provides a uniform method for encoding access control information that is independent of any particular security policy. The ACIS also provides a standard algorithm for interpreting and comparing access control attributes. The access control framework provides for authentication data and access control checks that will allow communication between different SDNS users/systems when their respective security policies allow it. The framework provides two processes: a Peer Access Approval process for interpreting the data of the four-tiered mode, and the Peer Access Enforcement Process for enforcing access control on a Protocol Data Unit (PDU) basis [NSA 1989e; NSA 1989f; NSA 1989g].

NSA is working with NIST to incorporate the SDNS protocols into U.S. GOSIP. The SDNS protocols will also be introduced into the ANSI by NIST and, if accepted, into the ISO OSI Security Architecture. SP3 and SP4 have already been submitted by ANSI to ISO: SP4 has been accepted as a new work item (part of the Transport Layer Security Protocol), and SP3 is expected to be accepted as a new work item after some modifications (part of the Network Layer Security Protocol). Testing of breadboard hardware with the SDNS protocols was conducted in 1989.

9.2.4.2 NIST Recommendations

The NIST approach to OSI security standards includes the following features [DCA 1989a]:

- Security encapsulation standard to provide cryptographic protection of integrity and confidentiality. A common format and processing standard is needed that is independent of the algorithm to be used.
- Security Protocol at Layer 2 (SP2), between the logical link control and the media access control protocols. This is being developed by IEEE under P802.10 as a Standard for Interoperable LAN security (described below).
- Security Protocol at Layer 3 (SP3). There are four subclasses: N-no routing, A-routing but no fragmenting and reassembly, I-fragmenting and reassembly, and D-fragmenting and reassembly for DoD Internetwork Protocol.
- Security Protocol at Layer 4 (SP4).
- Mail handling security system for MHS, to be used between the User Agent and the Transfer Agent to encapsulate the entire message contents; this requires posted keys and certificates. (One candidate is from X.411; another is the MSP from SDNS.)
- Cryptographic key management, a service to be provided at the Application Layer to support real-time (SP2, SP3, and SP4) as well as posted (MHS) requirements. Current proposals are based on private key (ANSI X9.17) or public key (SDNS) techniques.
- Security labels and labelling. These are planned to be strongly coupled with data.
- Authorization and access control. These features would permit policies to be specified within security domains and would support multiple policies and models (candidates are from ECMA and SDNS).

In addition, NIST is developing standards for digital signature and nonrepudiation where a message and the identity of the sender are cryptographically combined in such a way that any unauthorized change to the message is detectable and the originator cannot deny creating the message. This feature would require trusted notarization and storage. Finally, NIST is developing standards outside the OSI model for personal identification and authentication. Approaches include knowledge, token, or physical means. Technologies being considered include a smart card and use of passwords. A NIST workshop in September 1990 addressed integrity guidelines, but to date no written results have been forthcoming. The current concentration of NIST is on beginning the

development of a new set of Information Security Product Evaluation Criteria, better known as the Federal Criteria.

The NIST OSI Implementor's Workshops have a Special Interest Group (SIG) on OSI Security Architecture. The purpose of this group is to develop an overall OSI security architecture that is consistent with the OSI Reference Model and that economically satisfies the primary security needs of both the commercial and Government sectors. The SIG on OSI Security Architecture plans to address key management and security management functions that must be performed between the layers and the peer entities defined in the OSI architecture. Once SP3 and SP4 are adopted as Draft International Standards, the SIG on OSI Security Architecture can consider them for Interim OSI Implementor's Agreements. NIST is in the process of developing a FIPS that would specify the format for a security label for the U.S. GOSIP telling protocol processing entities how to handle unclassified but sensitive data communicated between open systems. An initial draft was issued February 1991.

9.2.4.3 ECMA Recommendations

In December 1989, ECMA issued a standard (ECMA 138) entitled *Security in Open Systems--Data Elements and Service Definition.* It is based on ECMA TR 46, *Security Framework* [ECMA 1988], which describes a framework for the development of security provisions in the Application Layer. ECMA 138 defines data elements and services for support of a multi-user, multi-vendor, distributed system environment.

9.2.4.4 IEEE Work on Secure Local Area Networks (LANs)

Draft standards are being developed for secure LANs. IEEE P802.10 has released (January 1989) a draft of the Standard for Interoperable LAN Security (SILS) [SILS 1989]. The draft standard provides different service interfaces for key management, secure data exchange, and security management:

- IEEE P802.10A - *Interoperable LAN Security (SILS) - The Model*
- IEEE P802.10B - *SILS - Secure Data Exchange*
- IEEE P802.10C - *SILS - Key Management*
- IEEE P802.10D - *SILS - Security Management.*

Security management may be expanded to include fault, performance, and configuration management as well. In addition, IEEE P802.2 is considering an optional security sublayer for logical link control [LLC 1988].

9.2.4.5 BLACKER

On the Defense Integrated Secure Network (DISNET), the Defense Communications Agency (DCA) operates a standard end-to-end encryption (E3) system called BLACKER. A BLACKER front end (BFE) device is installed on each host-to-switch access path of all hosts used by subscribers, including terminal access controllers. The BLACKER system includes key distribution center (KDC) and access control center (ACC) hosts that automatically manage encryption keys via DISNET. BLACKER ensures that no network malfunction can permit or cause an unencrypted packet to be delivered to a host not authorized to receive it [DCA 1990; Shirey n.d.; DCA 1989b].

BLACKER is designed to satisfy Class A1 of the DoD Trusted Computer System Evaluation Criteria (TCSEC), also known as "the Orange Book," by encrypting the application data in each X.25 packet while leaving header data unencrypted for backbone use. BLACKER makes DISNET multilevel secure in three ways. First, BLACKER separates subscriber security communities from each other, allowing the DISNET communities to share one backbone. Second, on the host side, the BFE recognizes a security label on each packet, allowing DISNET to serve a multilevel secure host through one BFE. Third, BLACKER separates the entire host community on one side of the BFEs from the backbone on the other, allowing the backbone to operate at a lower, less costly security level.

The host interface to the BFE is based on standards defined for the 1983 DDN X.25 interface, and requires that the Internet Protocol (IP) be used as the next layer above X.25. The BFE presents a Data Circuit-Terminating Equipment (DCE) interface to the host. Only DDN "Standard Service" X.25 is offered at the host interface; no provisions for "Basic Service" will be made. The BLACKER interface is, however, neither a pure X.25 interface nor a mere subset of X.25, but rather must be developed from X.25 interfaces.

The BFE conforms to the following Layer 3 specifications [DCA 1989b]:

- Defense Data Network X.25 Host Interface Specification, DCA, December 1983
- Interface Between Data Terminal Equipment (DTE) and Data Circuit Termination Equipment (DCE) for Terminals Operating in the Packet Mode on Public Data Networks, Recommendation X.25, CCITT, 1980
- WD2512 X.25 Packet Network Interface (LAPB), Western Digital Corporation, 1989.

In the fall of 1989, a multi-Service demonstration that used BLACKER communications security and off-the-shelf gateways and routers was held in the United States. The Integrated Tactical-Strategic Demonstration Network (ITDN) used only non-developmental item components, standard data communications protocols (X.25 with TCP/IP), and existing military communications systems. ITDN interconnected automated systems at multiple echelons at widely dispersed (over 1,000 miles) locations with multiple-security-level interconnected networks.

Work similar to BLACKER is being done in other NATO nations to achieve the same ends.

9.2.4.6 Computer Security (COMPUSEC) Guidance

In order to guarantee secure handling of data and information technology systems, it is necessary to comply with security standards appropriate to the respective risks in differing operational environments. Commonly referenced security standards for COMPUSEC guidance are [CSC 1985; CSC 1985a; CSC 1985b; CSC 1987; ITSEC 1990]:

- *Computer Security Requirements--Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments* (Yellow Book), issued by the DoD Computer Security Center (DoDCSC) in June 1985
- *Technical Rationale Behind CSC-STD-003-85: Computer Security Requirements--Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments* (Yellow Book Rationale), issued by DoDCSC in June 1985
- *Department of Defense Trusted Computer System Evaluation Criteria* (Orange Book), issued under the authority and in accordance with DoD Directive 5200.28 in December 1985
- *Trusted Network Interpretation* (Red Book), issued by the National Computer Security Center in July 1987
- *Information Technology Security Evaluation Criteria (ITSEC)--Harmonised Criteria of France, Germany, The Netherlands, and the United Kingdom,* Draft, Version 1, 2 May 1990.

9.3 Status of Standards for OSI Management

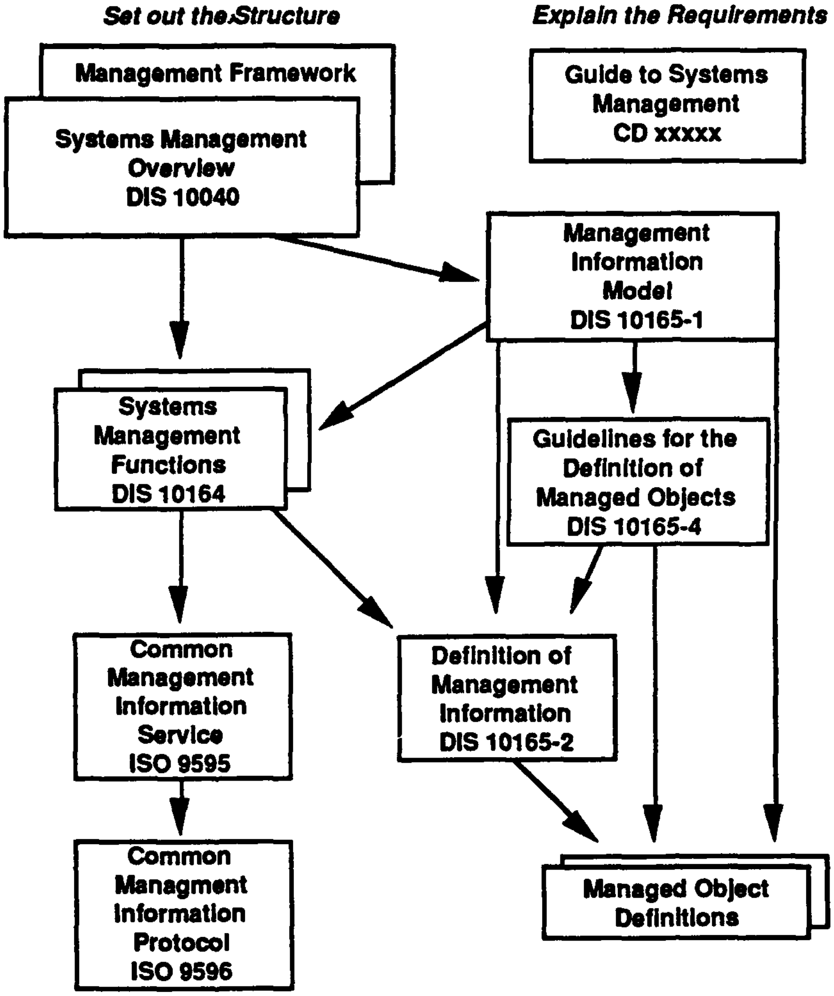
Part 4 of the OSI Reference Model, *Management Framework* (ISO 7498-4) identifies three areas of OSI management: systems management, layer management, and application process management. Development of international civil standards for the overall management architecture and for systems management is being coordinated through SC21/WG4 on OSI Management.

Figure 14 identifies the classes of OSI management standards and indicates the relationships among these classes. ISO standards are identified where they apply. One standard, CD xxxxx, *Guide to Systems Management*, has not yet been completed. It will be informative, independent of the other standards, and based on the guidelines contained in the early working documents on the five management functional areas: fault, configuration, security, accounting, and performance.

Work is progressing in SC6/WG2 and WG4 on OSI management in the lower layers. A committee draft specification (CD 10733) of the elements of network layer management information has been developed [SC6 N 6413, December 1990]. SC6 has developed a set of general principles for the definition of lower layer management [SC6 N 5784, January 1990; SC21 N 4630, April 1990]. These principles extend and refine the *Guidelines for the Definition of Managed Objects* (DIS 10165-4).

9.3.1 Development of OSI Management Standards

Network management standards are being developed by the ISO/IEC JTC1 SC21/WG4. TSGCE SG9 activities have been directed at identifying issues and positions of concern to military applications and influencing the direction of the work in ISO/IEC. The emphasis of the TSGCE SG9 issues has been in the area of quality of service (QoS).



Source: [SC21 N 4865 1990]

Figure 14. OSI Management Standards

9.3.2 ISO Approach to OSI Management[33]

OSI Management concerns itself with three things: inter-system communications carrying management information, structure of the management information, and management functions to be undertaken by end systems. There are three ways by which management information is communicated:

- Systems Management protocols at the Application Layer
- Layer management protocols at lower layers

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33 The discussion of the ISO approach to OSI management is taken from a working paper, *Open Distributed Management Standards--The OSI Management Approach,* A. Langsford (British Standards Institute IST21/P4 Chair), July 1989, UNCLASSIFIED.

- Normal operation of layer protocols.

Systems Management is the preferred method. The others are required only because OSI Management concerns the resources and activities needed to monitor and control the open communications environment. They are not required for management outside OSI Management.

Systems Management uses a Common Management Information Protocol (CMIP) (ISO 9596) to communicate information between systems. This identifies information to be transferred and whetner the transfer concerns an event report or an operation. Event reports are generated to notify another system of an asynchronous happening. Operations can monitor data and can exercise control either by assigning data values or initiating actions through a synchronous communication between end-systems.

9.3.2.1 Functional Areas

Establishing the scope of OSI Management is deemed necessary to establishing a consensus concerning the requirements. This led to identifying five functional areas for management: fault management, configuration management, accounting management, performance management, and security management. Although this approach had some advantages in resolving basic elements of functionality, it also exercised a constraining influence over the organization of work. Each functional area became concerned with its narrow perspective. This led to questions concerning the interplay between functional areas, exemplified by the following: "How does one handle standards for reconfiguring a system once a fault has been detected?"

9.3.2.2 Focus on Managed Objects

A clarification came from a shift of emphasis to the data of concern to management. Only when the data have been defined are the functions, which use the data through monitoring or controlling activities, considered. This has resulted in simpler functional standards. Each function can now stand alone rather than being bound into a composite document covering all the functions conceived as belonging to a particular area. It also enabled functions that cross the preconceived functional area boundaries to be handled in a natural manner. The result is that a particular function can be issued as a CD proposal when it is deemed to be technically stable without being unduly delayed by less mature work considered as belonging to the same functional area.

With this shift of emphasis towards data, the aim is now to identify the objects of concern to management, their attributes, and the operations that may be performed upon them. The communication services are thus the vehicles for carrying the values of attributes and a coded field identifying the operation to be carried out on a specific object, not for carrying information specifying a functional area. The approach is very close to (but not quite identical with) object-oriented methods. It has meant that work has concentrated on the management interchanges between systems performing a managing role and systems operating in an agent role manipulating internal managed objects. There has been little investigation of management exchanges between peer, managing entities, or of the management procedures invoked by managers.

The object-oriented approach has enabled OSI Management experts, in collaboration with those developing standards for various OSI layer protocols, to identify classes of managed objects and commonly used attributes. This in turn has promoted the development of a standard naming scheme through which to identify instances of object classes. The naming scheme is based on that used for Directory services. This facilitates the use of directories, conforming to ISO 9494 (CCITT Recommendation X.500), when management makes references to OSI objects.

A March 1991 paper entitled *Proliferation of Managed Objects* [SC21 N 5756] notes that many groups within CCITT and ISO are developing managed object definitions without the benefit of overall coordination. It suggests that this problem can only be solved by taking an overall view of managed object definition activities that requires a global management information authority, capable of influencing the activities of at least all the standards bodies. Another March 1991 paper [SC21 N 5815] proposed *A General Model for Managed Object Relationships*.

9.3.2.3 Distributed Processing Aspects

The shift of emphasis has been further beneficial in bringing into relief the fact that some management has been recognized as a distributed processing activity with its own managed objects. For example, the "event forwarding discriminator" takes management decisions about what should be done to asynchronous notifications flowing from OSI managed objects.

Thus, OSI Management standards are beginning to reveal explicitly what has always been known by management specialists; i.e., management is a distributed processing activity and has much in common with other distributed processing activities.

Management's distinguishing feature is that the scope of the distributed application is limited to manipulating the information processing, storage, input/output, and communications environments themselves. Hence, particular attention is paid to controlling the permission to obtain an act upon system information.

9.3.2.4 Results of Work in OSI Management

OSI Management has had a long learning process. The lessons learned have been valuable and appear to be applicable to management in general. The following steps are important in creating new management standards:

- Establish a requirement, since this sets the scope for the standard.
- Identify the objects of concern to management through which that requirement is realized. With identification of the objects goes the identification of their attributes, operations, and of any objects that can be encapsulated within the identified objects.
- Establish a naming scheme for the objects and their attributes.
- Identify management procedures that, through monitoring and controlling activities, meet the requirement. Where a procedure requires inter-system communication, the communication is provided through the use of CMIP.

The Structure of Management Information (SMI) standards for OSI set out rules for specifying managed objects, attributes, and their operations. Although detailed investigations remain to be carried out, first impressions are that these rules are applicable to all aspects of management. However, it could be that further investigation will reveal places where detail may need to be refined.

OSI Management standards identify a number of attributes that are common to many management activities (e.g., counters, gauges, thresholds, status, logs) and many events that have general applicability (e.g., fault reporting, exception handling). Though not yet as well developed, it appears that OSI management procedures for testing, accounting, managing, and accessing logs have the same general applicability. Adopting this work as a basis and providing extensions where required will (a) obviate rework, (b) help limit the unnecessary proliferation of managed standards, and (c) help reduce the diversity of management software that suppliers have to write to support open distributed management.

In communicating related sets of operations to be performed or invoking remote operations, a managing system may wish to assert relative priorities to various tasks. If and how priority should be handled and communicated through CMIP is an open question.

9.3.2.5 Conformance

SC21/WG4 has only begun to describe how conformance statements should be constructed so that they apply meaningfully to OSI Management. The one exception is CMIP for which, being a conventional Application Layer protocol, the task of generating conformance statements is straightforward.

The main problem is that OSI Management is concerned not just with "how" something is communicated (CMIP) but "what" is communicated (SMI) and "why" (management functions and procedures). Whereas conformance and particularly the demonstration of conformance through conformance testing is readily applied to CMIP since the communication is visible and monitorable, the "what" and "why" require that conformance testing be applied to activities taking place within end systems. There is a need to investigate whether the approach of the OSI Conformance Testing Methodology is applicable or whether another method needs to be developed. Any method must recognize the distributed nature of management operations and so would probably be appropriate to other classes of distributed processing enterprise.

Consideration of conformance to management standards, with the wider scope of open distributed processing, could have the beneficial effect of clarifying the conformance requirements, conformance clauses, PICS proformas (or the equivalent), and profiles for OSI Management standards [Langsford 1989].

9.3.3 ISO Standards for OSI Management

9.3.3.1 Status of OSI Management Standards

The following are the standards documents being developed in ISO by SC21/WG4 for OSI management:

- *OSI Management Framework,* ISO 7498-4, November 1989. The Framework document provides an architectural overview (CCITT X.700).
- *Systems Management Overview,* ISO 10040, September 1990 [SC21 N 4865]. The *Overview* document provides more detailed architectural concepts. It may contain normative material that an implementor must know

but will probably not contain specific requirements that would be reflected in conformance testing.

- *Systems Management*, ISO 10164:
  - Part 1: *Object Management Function*, ISO 10164-1 (CCITT X.730).
  - Part 2: *State Management Function*, ISO 10164-2, 1990 [SC21 N 4856] (CCITT X.731).
  - Part 3: *Attributes for Representing Relationships*, ISO 10164-3, 1990 [SC21 N 4857] (CCITT X.732).
  - Part 4: *Alarm Reporting Function*, ISO 10164-4, 1990 [SC21 N 4858] (CCITT X.733).
  - Part 5: *Event Report Management Function*, ISO 10164-5, 1990 [SC21 N 4860] (CCITT X.734).
  - Part 6: *Log Control Function*, ISO 10164-6, 1990 [SC21 N 4862] (CCITT X.735).
  - Part 7: *Security Alarm Reporting Function*, ISO 10164-7, 1990 [SC21 N 4874] (CCITT X.736).
  - Part 8: *Security Audit Trail Function*, DIS 10164-8, July 1990 [SC21 N 4955]--IS status in 1992 (CCITT X.740).
  - Part 9: *Objects and Attributes for Access Control*, CD 10164-9, 1990 [SC21 N 4956] (CCITT X.741).
  - Part 10: *Accounting Meter Function*, CD 10164-10, 30 January 1991 [SC21 N 5648] (CCITT X.742).
  - Part 11: *Workload Monitoring Function*, CD 10164-11, 30 January 1991 [SC21 N 5649] (CCITT X.739).
  - Part 12: *Test Management Function*, CD 10164-12, 21 January 1991 [SC21 N 5517] (CCITT X.745)
  - Part 13: *Summarization Function*, CD 10164-13, 21 January 1991 [SC21 N 5519] (CCITT X.738).
- *Structure of Management Information (SMI)*, DIS 10165:
  - Part 1: *Management Information Model*, DIS 10165-1, September 1990 [SC21 N 4484] (CCITT X.720).
  - Part 2: *Definition of Management Information*, DIS 10165-2, September 1990 [SC21 N 4867] (CCITT X.721).
  - Part 3: Cancelled in November 1989 by recommendation of SC21 and incorporated into Part 2.
  - Part 4: *Guidelines for the Definition of Managed Objects*, DIS 10165-4, September 1990 [SC21 N 4852].
  - Part 5: *Generic Management Information*, CD 10165-5, July 1991 [SC21 N 6025]
  - Part 6: *Requirements and Guidelines for Management Information Conformance Statements*, CD 10165-6, July 1991 [SC21 N 6027]
  - Part 7: *Management Information Register and Registration Procedures*, WD 10165-7
- *Common Management Information Service (CMIS) Definition*, ISO 9595: 1991 (E), 7 January 1991 [SC21 N 5302] and [SC21 N 5582 Rev.,

21 January 1991] [CCITT X.710]; CCITT and ISO/IEC are collaborating on CMIS and CMIP. CMIS defines services for acting on an object and includes creation and deletion. Services can apply to values from a set of attribute values; the attribute values can have the structure of a table, so that services can affect entries, entire rows, and entire columns (CCITT X.710).

  - DAD 1: *Cancel/Get Service,* February 1990 [SC21 N 3876].
  - DAD 2: *Add/Remove Service,* February 1990 [SC21 N 3877].
  - CDAM 3: *Support of Allomorphism,*[34] November 1990 [SC21 N 4966].
  - CDAM 4: *Access Control,* December 1990 [SC21 N 5510]; CMIS has an access control field--the issue is how to use it.

- *Common Management Information Protocol (CMIP) Specification,* ISO 9596-1, 7 January 1991 [SC21 N 5303]; CMIP defines peer protocols for layer services between Systems Management entities (CCITT X.711).
  - DAD 1: *Cancel/Get Protocol,* February 1990 [SC21 N 3878].
  - DAD 2: *Add/Remove Protocol,* February 1990 [SC21 N 3879].
  - PCDAM 3: *Support of Allomorphism,* July 1990 [SC21 N 4967].
  - PDAM 4: *State Tables for CMIP,* January 1990 [SC21 N 4058]
  - WDAM 5: *Access Control.*
- *Common Management Information Protocol (CMIP) Specification,* DIS 9596-2, *PICS Proforma,* December 1990 [SC21 N 5509].
- *Telecommunications and Information Exchange Between Systems - Elements of Management Information Related to OSI Network Layer Standards,* CD 10733, January 1991 [SC21 N 5560]

As part of the Summarization Function (CD 10164-13) work, the Performance Management (PM) Group of SC21 WG4 was requested to develop a general model for scheduling in management functions. As a result of their work, the PM group has recognized that a general scheduling model has wider applicability than performance management and recommends that this work be progressed independently of the Summarization Function [SC21 N 5545 1990].

In November 1990, it was agreed that after Version 2 of CMIS and CMIP there will be no further releases (either in the form of addenda or completed standards) that could affect interoperability before 1994 [SC21 N 5546 1990].

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34 An object in a refined class (i.e., a subclass) of a class definition (e.g., a modem) could behave in certain situations as if it were the parent. This characteristic, called polymorphism or more recently allomorphism, would support backwards compatibility. The way in which an object would respond would depend on how it is addressed. This work will lead to a change in both CMIS and CMIP.

9.3.3.2 New Work Items

Work in SC21/WG4 on OSI management is continuing on several new parts for *Systems Management*, DIS 10164.

- WD 10164-cdt: *Confidence and Diagnostic Test Classes*, December 1990 [SC21 N 5518], second working draft.
- WD 10164-X: *Software Management Function*, July 1990 [SC21 N 6040], expected to be an addendum to DIS 10165-2 (CD text expected in June 1992).
- WD 10164-A: *Time Management: Representation of Time*, July 1990 [SC21 N 4953] deals with the distribution and synchronization of time in a distributed environment. CD expected November 1991.
- WD 10164-sm: *Systems Management Relationship Model*, August 1990 [SC21 N 4948; JTC1 N962]--expected to use entity-relationship modelling.
- WD 10164-rtm: *Response Time Monitoring*, August 1990 [SC21 N 4949; JTC1 N963].
- WD 10164-s: *Scheduling Function*, June 1991 [SC21 N 6021].

New work items include:

- *Systems Management Tutorial*, August 1990 [SC21 N 4942; JTC1 N957] (planned to be a new technical report) (CCITT X.702) [SC21 N 4970 1990].
- *Extended Systems Management Architecture*, August 1990 [SC21 N 4943; JTC1 N958] (planned to be an amendment to ISO 10040).
- *Formal Descriptions of CMIP*, July 1990 [SC21 N 4947].
- *Generic Managed Objects*, 16 January 1991 [SC21 N 4944; JTC1 N959; SC2 N 5606]. (It has yet to be decided whether this work will result in an addendum to 10165-2, a new part to 10165, or a standard in its own right.). Provides developers of OSI specifications that contain managed object definitions with generic definitions of managed object classes that will:
  - Provide common superclass definitions from which layer- or resource-specific object class definitions may be derived
  - Assist with the development of common elements of object class definitions across multiple layers or components of layers
  - Reduce duplication of effort in other working groups by identifying commonly useful definitions.
- *Management Information Register and Registration Procedures*, 2 February 1991 [SC21 N 4945; JTC1 N961; SC21 N 5687]--to define a mechanism for registering system management information and procedures for maintaining the register. The Management Information Register would contain information describing:

- Support managed object classes
- Generic managed object classes
- Definitions of attribute types, support objects, system management notifications, system management actions, name bindings, and management information parameters.

• *Managed Object Conformance Statement (MOCS) Proformas,* 14 February 1991 [SC21 N 5686]--to provide requirements and develop a standard specification technique (template) for MOCS proforma, thus helping to ensure their completeness, consistency, and ease of use. MOCS proformas are analogous to PICS proformas, but apply to managed object definitions as opposed to protocols. Designed to be a new part of DIS 10165-4.

• *Management Information for the OSI Upper Layers* (approved by JTC1 in May 1990) [SC21 N 4912 1990]. CD originally targeted for June 1991.

• *General Model for Relationship Management* to support DIS 10164-3, which addresses three methods of representing relationships: by name binding, by attributes, and by managed objects [SC21 N 6041 1990].

9.3.3.3 Systems Management, DIS 10164

DIS 10164, *Systems Management,* establishes user requirements for each management function, establishes a model that relates the services and generic definitions provided by this function to user requirements, defines the services provided, defines generic notification types and parameters documented in accordance with the guidelines for the definition of managed objects, specifies the protocol necessary to provide the service, specifies the abstract syntax necessary to identify and negotiate the functional units in the protocol (if necessary), defines the relationship between the services and SMI operations and notifications, specifies compliance requirements placed on other standards that make use of these generic definitions, defines relationships with other systems management functions, and specifies conformance requirements. DIS 10164 does not define implementation aspects, specify the manner in which management is accomplished, define interactions that result in the use of management functions, specify services for establishment and normal or abnormal release of a management association, or define managed objects.

DIS 10164 defines particular systems management functions and how these are achieved by use of CMIS. ASN.1 is the notation used to express the abstract syntax of the data elements associated with managed object, attribute, event, and action definitions that shall be carried in CMIP.

The major management functions addressed in SMI are defined in Table 23.

Table 23. Definitions of OSI Management Functions From DIS 10164

- Object management--ability to create, delete, examine, and change sets of management information that describe parts of the OSI environment.
- State management--the ability to examine and be notified of changes in state, to monitor overall operability and usage of objects in a consistent manner, and to give or withhold permission for the use of specific objects.
- Relationship management--the ability to examine the relationships among various parts of the system, to see how the operation of one part of the system depends upon is depended upon by other parts.
- Alarm reporting function--reports alarms, errors, and related information. Malfunctions will range in severity from minor, where a minimal impact upon the quality of service to the user occurs, to major, where it is no longer possible to provide the quality of service requested (or promised to) the service user.
- Event report management--the ability to specify conditions to be satisfied by a potential event report relating to a particular managed object or a set of managed objects, in order to be sent to specified destinations.
- Log control--the ability to preserve information about events that may have occurred or operations that may have been performed by or on various objects.
- Security alarm reporting function--provides such capabilities as the means to receive notifications of security-related events, alerts of any misoperations in security services and mechanisms, alerts of attacks on system security, and information as to the perceived severity of any misoperation, attack, or breach of security. The standard provides notifications that include reporting of the clearance of fault conditions.
- Security audit trail--the ability to maintain a record of security-related events that occur in the management domain and to review and analyze these events to detect security breaches, malfunctions, and effectiveness of the security services and mechanisms that are implemented pursuant to the security policy.
- Access control--provides consistent levels of granularity necessary to a homogeneous control policy, preventing management notifications from being sent to unauthorized recipients, preventing initiators from having access to management operations, and protecting management information from unintended disclosure. Various levels of access control will be supported: some users may be given read and write access to specific attributes while other users have only read access or no access; some users may be granted access only to specific managed objects; and some users may not be allowed to establish management communications at all.
- Test Management Function--remote control of tests involving real open systems and the specification of tests that exercise OSI resources.
- Confidence and Diagnostic Test Classes--defines service in the form of test classes that are required in order to investigate the ability of a resource to perform its allotted function, the ability of the communications mechanism to make a connection between a number of open systems and to transfer data without modification between a number of open systems, the integrity of a protocol, and the effect of increased utilization of a resource.
- Measurement Summarization Function--measures throughput, time delays, message round trips, response times, and other measures of congestion and resource utilization for performance monitoring and statistics related to performance monitoring.

9.3.3.4 Major Remaining Issues for DIS 10164

The following technical issues are not yet addressed by DIS 10164 [SC21/WG4 1989]:

- Renaming managed objects--requirements for renaming managed objects, including classes to be renamed, conditions under which rename would be

permitted, constraints on renaming objects in standardized procedures, and changes that need to be coordinated to make a renaming operation consistent and meaningful.

- Service access control--mechanism to address the need for individual open systems to have the option of protecting themselves against the invocation of services that would forcibly change existing configured relationships among managed objects.
- Startup and shutdown--addressing the requirement to manage the state of an object as regards invoking startup (or initialization) and shutdown.

9.3.3.5 Structure of Management Information (DIS 10165)

The purpose of DIS 10165-1, *Management Information Model,* is to give structure to the management information conveyed externally by systems management protocols and to model management aspects of the related resources (e.g., an X.25 protocol machine). Managed objects are abstractions of data processing and data communications resources (e.g., protocol state machines, connections, modems) for the purposed of management. It is the attributes, operations, and notifications of managed objects that are visible to management, whereas the internal functioning of the managed object (i.e., the resource it represents) is not otherwise visible to management. DIS 10165-1 describes the model of management information in terms of managed objects and the set of operations that may be performed upon them and notifications that they may generate. It also defines, using object-oriented principles, key concepts such as inheritance, allomorphism, containment, and naming as they relate to managed objects.

DIS 10165-2 defines the generic object classes, support managed object classes, abstract attribute types, attributes types, notifications types, action types, parameter types, and associated abstract syntaxes that may be applicable to a number of different standards. It also specifies compliance requirements place on other standards that make use of these definitions.

DIS 10165-4 defines the management information that is to be transferred or manipulated by means of the OSI management protocol and the managed objects to which that information relates. DIS 10165-4 provides developers of managed object class definitions with the information and documentation tools that are required in order to produce complete managed object class definitions.

9.3.4 Telecommunication Management Network (TMN)

The Telecommunication Management Network (TMN) is concept developed by CCITT (Recommendation M.30) to manage a telecommunication network (e.g., the public telephone network or an ISDN). A TMN is conceptually a separate network that interfaces a telecommunications network at several different points to receive information from it and to control its operations. A TMN may use parts of the telecommunications network to provide for its own communications.

Architecturally, the TMN functions are divided into three blocks:

- Operation System Function (OSF) that processes the information related to telecommunication management to support or control the realization of various telecommunication management functions.
- Mediation Function (MF) that acts on information passing between Network Element Functions (see below) and OSFs to achieve smooth and efficient communication. The main MFs are communication control, protocol conversion, data handling, communication of primitives, processing involving decision making, and data storage.
- Data Communication Function (DCF) that provides the means to transport information related to telecommunication management between functional blocks.

The three functional blocks can communicate with two external blocks. One is the Network Element Function (NEF) that communicates with a TMN for the purpose of being monitored and/or controlled. The other is the Workstation Function (WSF) that provides the means for communications between function blocks (OSF, MF, DCF, and NEF) and the user. The current draft of the *NATO C3 Architecture Communications Subsystem* (July 1989) indicates that the management of the NATO ISDN (see Appendix K) will be based on the TMN concept [Man 1990].

9.3.5 Military Concerns in Network Management

Some concerns in the OSI management area involve the direction and support of work being done by ISO for Quality of Service (QoS) and multipeer/multiaddressing. Both of these areas were reassessed in 1989 due to lack of support from the nations. Specifically, a formal question[35] has been raised and put to a ballot on the need for a

[35] ISO/IEC JTC1/SC21/WG1 Question 62: "Is Quality of Service an architectural issue which needs overall guidance and consistent approach across all layers?" Balloting closed in May 1989.

framework for quality of service within the ISO standards. Since these areas have been found to be priority items for achieving military requirements, it is important for the nations individually and collectively to express their support for additional work in these standards areas.

The Ad Hoc Working Group on OSI Management (AHWG-OM) of TSGCE SG9 has been formed to address OSI management issues for NATO.[36] The major standing document of the AHWG-OM is *NATO Requirements for Open Systems Management* [AHWG 1990]; some key elements are the following:

- Part 1: *Rationale and Objective* (of which Section 7 is Military Features and Their Impact on OSI Management and Annex A.2 is the Work Plan), 28 June 1990
- Annex H: *Notes Concerning the Quality of Service Issue,* Third Draft, 9 February 1990
- Appendix 4, *Requirements for a Network Management Broadcast Facility,* 1 May 1990.

9.3.6 Quality of Service (QoS)

In the framework of OSI, QoS provides the capability to measure the service level provided by the communications service provider and the means to request a target service from the communications service provider. QoS parameters now used in ISO standards[37] include transit delay and priority.

SC21/WG1 posed Question 62 (Q62) in 1989 to query whether a QoS Architecture was necessary since such an architecture would require modification to the OSI Reference Model. The first step to developing such an architecture would be defining the components of a QoS Framework. A concern of several national bodies in WG1 is that a new QoS Architecture would destabilize the existing standards. At the May 1990 SC21 Plenary in Seoul, WG1 did not progress the QoS Framework as a new work item. WG1 reported to SC21. In June 1991, it was again proposed as a new work item.

The AHWG-OM (see Appendix K) has identified [WG/1 1990; AHWG 1989] the following deficiencies and requirements relative to QoS:

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36 The work TSGCE SG9 working groups is discussed in Appendix K. The AHWG-OM is addressed in Appendix K.

37 ISO/IEC references to QoS are in Layer 3 (ISO 8438), Layer 4 (ISO 8072, 8073), Layer 5 (ISO 8326), Layer 6 (ISO 8822), and Layer 7 (ISO 8649, 8650, 8571-3).

- Only static QoS parameters have been defined--the relationship of various QoS parameters to each other and actions to take upon dynamic change in QoS are not yet supported.
- A tight coupling between QoS and communications services is needed to support applications in areas such as military and real-time process control and high assurance of message delivery. Specifically, this means that applications need:
    - Capability to clearly express the QoS requirement to the underlying communications service
    - Notification of changes in QoS
    - Close monitoring of the QoS
    - Assurance that QoS is maintained in a deterministic manner.
- While QoS's need of the layer services have led to protocol definitions that include parameters for specifying QoS, no syntax or semantic meaning of those parameters has been defined.

Further, the AHWG-OM has recommended that:

- An overall framework for OSI QoS be developed and, specifically, ISO/IEC SC21/WG1 raise the priority of QoS discussions in this area.
- QoS be expanded to provide five functions: establishment, monitoring, maintenance, notification of change, and negotiation.
- The definition of QoS be modified to include the following four classes of QoS parameters:
    - Quality of addressing--the correct assignment of addresses to the originator and the recipient.
    - Quality of message--the reliability of message delivery against data loss, data corruption or insertion, misdelivery, duplicate delivery, or out-of-sequence delivery.
    - Quality of timeliness--the delay of transferring information across a communications service, including specification of requirements on time limits for delivery of a message. The latter may be in terms of the time after which the message is no longer valid, allowable delay in the transfer, and the action to take on failure to meet the criteria.
    - Quality of confidentiality--the ability of the system to protect its resources from unauthorized use and to prevent unauthorized interception of information relative to the transfer of a message. Clearly this quality overlaps security requirements.

The AHWG-OM in its meeting in June 1990 recommended three steps for progressing work on QoS: (1) establish an ad hoc working group on QoS in TSGCE SG9 to define QoS requirements and a QoS Framework; (2) apply the QoS Framework in other SG9 working groups; and (3) provide additional information to ISO and other standards

bodies on the need for QoS. AHWG-OM recommended that the proposed framework consider the application QoS parameters, the application actions (procedures used by applications in processing QoS information), and QoS facilities for establishment, monitoring, maintenance, notification, and negotiation of QoS [AHWG 1990a].

A key background paper for QoS is *Management Requirements Arising from a NATO Study of Quality of Service* [Kennedy et al. 1989]. This paper identifies QoS requirements in such areas as specification, establishment, application actions, monitoring, maintenance, notification, negotiation, information flow, and applicability. It also addresses the QoS framework, information model, and interaction model. Four QoS parameters are identified: addressing, message, timeliness, and confidentiality. The June 1990 recommendations of the AHWG-OM to SG9 were based, in part, on material described in this paper.

9.3.7 Special Interest Groups for OSI Management

A number of special interest groups have been formed to promote standardization of OSI management. These include [AHWG 1990b]:

- Network Management Experts Group--formed within EWOS with plans to meet four times per year
- Network Management Forum (NMForum)--developing specifications that will be demonstrated in September 1990 during the first Network Management Showcase
- NIST Network Management Special Interest Group (NMSIG)--developing specifications for the *Stable Implementor's Workshop Agreements* with a target date of December 1990. The 1990 version will define, in coordination with EWOS and the NMForum, managed objects for LANs including FDDI, X.25, and ISDN. Additional managed objects would be defined in 1991 for Layer 3-7 protocols and routers and in 1992 for applications, operating systems, and database management systems.

9.3.8 ECMA Model for Management

In January 1987 the European Computer Manufacturers Association (ECMA) established [ECMA 1987] an abstract model for the management aspects of OSI. The framework provided by ECMA is designed to form the basis for the definition and specification of services and protocols that enable the planning, organizing, supervising, and controlling of the communication service that forms a part of a distributed information processing system. In this context, OSI management is defined as the collection and

interchange of information necessary for the management of those aspects of open systems that are relevant to Open Systems Interconnection. The abstract model addresses standardization in two areas:

- Semantics of the management information transferred or extracted from the management information base (where the structure of the information within the management information base is viewed as a local matter and not subject to management standardization)
- Services and associated protocols for the transfer of management information between open systems; this requires that both the syntax and semantics of the information transferred be specified.

ISO standards for OSI network management are being developed by SC21/WG4; they are discussed in Section 9.3.3.

9.4 Standards for Conformance Testing

Conformance testing is crucial to the achievement of OSI to ensure comparability of test procedures and results by different test centres. Conformance testing is defined by the United Kingdom's National Centre for Information Technology as

> the testing of a product against a published standard in order to determine the degree of conformance with that standard [Pink et al. 1991].

Standardization of conformance test suites needs to be based on a standard testing methodology and approach to test suite specification, which is reflected in ISO 9646, *OSI Conformance Testing Methodology and Framework.* Work has already begun in standardizing test suites based on ISO 9646 for X.25 terminals, the connection-oriented transport protocol (ISO 8073), MHS, FTAM, ACSEs, session, and presentation protocols. A detailed description of OSI conformance testing is provided in [Rayner 1987]. ISO/IEC work in conformance testing is done by SC21/WG1.

ISO 9646 is being developed in seven parts, five of which have achieved IS status [SC21 N 5108 ADD 1990]:

- ISO 9646-1, Part 1: *General Model,* May 1991 [SC21 N 5865] (CCITT X.290)
- ISO 9646-2, Part 2: *Abstract Test Suite Specification,* May 1991 [SC21 N 5867] (CCITT X.291)

- ISO 9646-2 PDAM1: *Amendment to Part 2 on Testing and Formal Description Techniques (FDTs)*, June 1991 [SC21 N 6174] (DIS expected March 1992; IS in December 1992)
- Annex to ISO 9646-2: *Guidelines for PICS Proformas* [SC 6 N 6243, 23 October 1990] is also under development (see 9.4.1)
- ISO 9646-3, Part 3: *The Tree and Tabular Combined Notation (TTCN)*, July 1991 (CCITT X.292)
- ISO 9646-3 WDAM1, *Amendment on Extensions to TTCN Including Parallel Tree*, March 1990 [SC21 N 4219, December 1989] (PDAM expected November 1991; DAM expected June 1992; AM expected June 1993)
- ISO 9646-4, Part 4: *Test Realization*, May 1991 [SC21 N 5869] (CCITT X.293)
- ISO 9646-5, Part 5: *Requirements on Test Laboratories and Clients for the Conformance Assessment Process*, May 1991 [SC21 N 5871] (CCITT X.294)
- CD 9646-6, Part 6: *Protocol Profile Testing Specification*, June 1991 [SC21 N 6177] (DIS expected March 1992; IS in December 1992)
- WD 9646-7, Part 7: *Requirements and Guidelines on Implementation Conformance Statement (ICS) and ICS Proformas*, June 1991.

There are five primary areas for standardization of conformance testing in the near future: multi-protocol (profile) testing, multi-party test methods, additional features in TTCN and multi-test case tables, and the nature of profile conformance testing and configurability [SC21 N 5082 1990], and implementation conformance statements. Specifically,

- *Protocol Profile Conformance Testing Methodology* (PPTM) was a proposal for a new work item, January 1990 [SC21 N4217; SGFS N9]. It is now its second working draft [SC21 N 5075, June 1991]. It will extend the OSI conformance testing methodology and framework (DIS 9646) to make it applicable to OSI protocol profiles as well as base protocols. This standard will supersede TR 10000-1 as far as conformance aspects are concerned. In addition to Part 6 of ISO 9646, PDAMs to parts 1,2, 4, and 5 of ISO 9646 on PPTM were issued in June 1991.
- *Multi-party test methods* addenda to parts of DIS 9646 [SC21 N 4218, January 1990] will define the main requirements concerning MPTM and a multi-party test architectural model. The model will be used to map abstract test methods on which to base the development of abstract test suites and means of testing for the various multi-party protocols and multi-party testing configurations using more than one protocol or more than one channel. A joint

meeting with CCITT SG VII was held February 1991 from which a WD emerged [SC21 N 5076], and PDAMs to parts 1, 2, 4, and 5 of ISO 9646 were issued in June 1991.

- Work on *TTCN extensions* has already begun. As an addendum to DIS 9646-3, *TTCN Extensions* introduces the notion of parallelism in order to ease the writing of test cases, provide a language means to describe explicitly the cooperation of (distributed) components of a test architecture, and to make TTCN a test notation that covers the aspects of a multiparty test methodology. WD text was distributed for comment in March 1990, and CD text was issued in June 1991.
- *Formal methods in conformance testing* is a proposal for a new work item, January 1990 [SC21 N 4215]. A joint meeting with CCITT SG X was held in November 1990, a WD was issued in July 1991 and CD text is expected in May 1992.

Additional topics to be addressed for conformance testing in 1991-1992 are ISDN and multimedia concerns, application of formal methods, and protocols for test support.

SC21/WG1 has noted concerns [SC21 N 4187 1989] about the available resources and direction of work on upper layer conformance testing. Work has slipped 2 years on abstract test suites for FTAM and 3 years for embedded test suites for ACSE, Presentation Layer, and Session Layer. There is an imbalance between work on the basic methodology and that applied to the actual conformance tests, specifically on abstract test suites.

The status of Abstract Test Suite (ATS) work as of June 1991 is as follows:

- SC21 N 3665, *Specific Partial ATS for Responder Tests,* submitted by NCC (UK). This test suite will be aligned with the TTCN IS version. Additional contributions are expected in October 1991. CD text is expected in October 1992; DIS text expected October 1993; and IS text expected October 1994.
- SC21 N 7018, *Common Partial Embedded ATS,* CD text anticipated May/June 1992.
- SC21 N 5903, *Presentation Connection-Oriented ATS, Common Partial ATS,* CD expected June 1992; DIS expected June 1993; IS expected June 1994.
- SC21 N 7016, *Presentation Connection-Oriented ATS, Specific Partial ATS.*
- SC21 N 3666, *ATS for CS Test Method,* submitted by AFNOR. WD expected June 1992; CD October 1992; DIS October 1993; IS October 1994.

EWOS has agreed [ITSTC 1989] to convene an activity to study and investigate OSI Conformance Testing Methodology. This work would examine central aspects of OSI

testing methodology that are necessary to support standardization of test specifications. CEN has been assigned leadership of the work.

TTCN is a unique, informal notation that was developed by ISO and CCITT for specifying generic and abstract test cases [ISO 4642-2 1987]. Other formal description techniques in use for this purpose are the Language of Temporal Ordering of Specification (LOTOS) and Estelle--both accepted in the *NTIS Transition Strategy*--and the System Development Language (SDL), developed by CCITT (Recommendation Z.100). Both Estelle and SDL are Pascal-based notations. These formal description techniques (FDTs) are described in detail in Section 9.4.2.

TTCN provides a notation in which generic and abstract test cases can be expressed in test suite standards, which is independent of test methods, layers, and protocols, and which reflects the abstract testing methodology of DIS 9646. TTCN provides a naming structure to reflect the position of test cases in the abstract test suite hierarchy (complete test suite, test groups, test cases, test steps, and test events). TTCN also provides the means of structuring test cases as a hierarchy of test steps culminating in test events.

Many organizations have been formed to address OSI conformance testing. These include Corporation for Open System (COS), OSINET, SPAG, European Committee for Standardization (CEN)/European Committee for Electrotechnical Standardization (CENELEC), NIST, Industrial Technology Institute (ITI), World Federation of Manufacturing Automation Protocol (MAP) and Technical and Office Protocol (TOP) User Groups, Conformance Testing Services-Wide Area Network (CTS-WAN), National Computing Centre (NCC), and EurOSInet. TSGCE SG9 is addressing [CA 1989] military requirements in this area and whether NATO-specific activities need to be supported. The following are areas in which existing civil organizations may be expected to contribute to conformance testing to support military requirements [Cardonna 1988]:

- Developing standards and conformance certification criteria: ISO, CCITT
- Developing abstract test suites for OSI upper layers: ISO
- Developing test profiles and provisioning testing under military requirements: COS, SPAG
- Developing site accreditation criteria: Industrial Technology Institute (ITI)
- Implementing site accreditation and testing tools, and specifying test control and maintenance procedures: NIST
- Developing standards and test methodologies: CEN/CENELEC, ANSI.

COS [COS 1989] and SPAG have now completed formal agreement to combine their conformance test products within a single integrated tool set (ITS). In addition, COS, POSI, and SPAG have completed (June 1989) an Initial Strategic Technical Cooperation Agreement that commits the organizations to a strategic cooperative arrangement designed to provide a common technical solution to conformance testing, building upon the ITS. The agreement is also known as "CPS" (both for Conformance Promotion Strategy and for COS-POSI-SPAG).

OSINET, a 55-member United States-based interoperability testing organization, has voted to reorganize under the auspices of COS. OSINET was formed in 1984 under the auspices of NIST to work in three specific areas:

- Research and development of test scripts used in OSI interoperability testing
- Interoperability testing and registration of announced OSI products
- Demonstration and promotion of OSI technology [OSN 1991h].

There is a need to harmonize testing and certification schemes to enable mutual recognition of results of testing internationally. In 1985, the Conformance Test Service (CTS) was set up under the CEN/CENELEC to support the development of test tools and provision of test services. In Phase I (1985-1986), it addressed the following topics: OSI protocols, software quality, programming languages, and GKS. In Phase II (1987-1988), it continued to address OSI protocols as well as SGML, ODA, POSIX, and the programming language C. Memorandum M-IT-03 defines a framework for testing and certification in Europe which aims to enable mutual recognition of results of testing. The European Committee for IT Testing and Certification (ECITC) is implementing M-IT-03 by setting up mechanisms for mutual recognition of test reports and certificates These include abstract test suites and recognition of test tools, services, and tested products. The Open Systems Testing Consortium (OSTC) was formed in 1989 on completion of the CTS-WAM project to ensure continued harmonization [Pink et al. 1991].

9.4.1 PICS Proformas

An approach used in conformance testing (and in other applications) to specify interoperability parameters for an implementation profile (or a functional profile) is called a protocol implementation conformance statement (PICS). A PICS specifies all the parameters and options required to show how a particular implementation meets static conformance requirements. As such, it is the first tool in conformance testing. A PICS proforma is a PICS template developed and standardized in conjunction with a protocol

standard. In the future, a PICS proforma can be expected to be required as part of the functional profile guidelines being developed by NIST, EWOS, AOW, NATO, and other standards bodies.

Since there are so many projects involving the development of PICS proformas, SC21/WG1 is developing an Annex of ISO 9646-2, *Guidelines for PICS Proformas* [SC6 N 6243, September 1990]. In order to harmonize their use, SC21/WG1 has also set up as a standing document a *Catalogue of PICS Proforma Notations* [SC21 N 5078, August 1990] to be updated as required.

9.4.2 Formal Description Techniques (FDTs)

FDTs are used to produce unambiguous descriptions of OSI services and protocols in a more precise and comprehensive way than natural language descriptions. Further, FDTs provide a foundation for analysis and verification of a description. The objectives of FDTs are to provide:

- Unambiguous, clear, and concise specifications
- Basis for determining completeness of specifications
- Foundation for analyzing specifications for correctness, efficiency, etc.
- Basis for determining consistency of specifications relative to each other
- Basis for implementation support.

There are three international standard FDTs that range from abstract to implementation-oriented: Estelle, LOTOS, and SDL. Since emerging standards are being written in one or more of these FDTs, the following sections are provided to give some technical information together with the basis, derivation, and character, for these description techniques [PDTR 10167 1989]. DTR 10167, *Guidelines for the Application of Estelle, LOTOS, and SDL*, July 1991, provides guidelines for applying these three FTs. A TR is expected in December 1991. A fourth FDT--TTCN--was described in Section 9.4.

SC21/WG1 has developing a working draft for *Architectural Semantics for FDTs* [SC21 N 4231, April 1990]. This work was planned to assist development of formal descriptions of standards for data communications, networking, and distributed computing. The draft defines and catalogues a set of selected elementary concepts, which act as a bridge between the architectural concepts and structures and the semantic models of the FDTs (Estelle, LOTOS, and SDL). SC21 approved the May 1990 recommendations developed by a reassessment of the work associated with the *Architectural Semantics for*

FDTs. The current work in SC21/WG1 will be terminated and a subproject initiated in SC21/WG7 in the area of ODP architectural semantics [SC21 N 4655 1990].

9.4.2.1 Estelle

Estelle (ISO 9074, *Estelle, A Formal Description Technique Based on an Extended State Transition Model,* July 1989) is a formally-defined specification language for describing distributed or concurrent processing systems, in particular those that implement OSI services and protocols. The language is based on widely used and accepted concepts of communicating non-deterministic state machines (automata). An Estelle specification defines a system of hierarchically-structured state machines. The machines communicate by exchanging messages through bidirectional channels connecting their communications ports. These messages are queued at either end of the channel. The actions of machines are specified in (extended) Pascal; hence, familiarity with Pascal makes Estelle specifications easily readable. Estelle uses Pascal data types in its data descriptions.

Estelle is based on an extended state transition model, i.e., a model of a nondeterministic communicating automaton extended by the addition of the Pascal language. Estelle may be view as a set of extensions to Level 0 of ISO 7185 (*Programming Language - Pascal*) that models a specified system as a hierarchical structure of communicating automata that may run in parallel and may communicate by exchanging messages and by sharing, in a restricted way, some variables. As in Pascal, all manipulated objects are strongly typed, which enables static detection (e.g., during compilation) of specification inconsistencies.

Estelle language mechanisms allow modelling of synchronous and asynchronous parallelism between state machines of a specified system. They also permit dynamic development of the system configuration. Estelle specifications can be prepared at different levels of abstraction, from abstract to quite implementation-oriented. The latter may be derived from the former with the aid of supporting tools. An Estelle tutorial has been developed and is intended to become Annex D (informative) of the Estelle base standard (ISO 9074 PDAM1, *Estelle Tutorial,* SC21 N 5710, 4 March 1991).

9.4.2.2 LOTOS

LOTOS (ISO 8807, *LOTOS, A Formal Description Technique Based on the Temporal Ordering of Observational Behaviour,* February 1989) is a mathematically-defined FDT, developed from a large, well-established body of theory based on three

mathematical techniques: Calculus of Communicating Systems (CCS), Communicating Sequential Processes (CSP), and ACT ONE. Having a well-defined mathematical foundation, it provides a solid basis for both analysis and development of reliable tools, including simulation, compilation, and test sequence derivation. The basic constructs of LOTOS allow modelling of sequencing, choice, concurrency, and nondeterminism in an entirely unambiguous way. In addition, LOTOS permits modelling of both synchronous and asynchronous communication. LOTOS, like SDL, uses abstract data types in its data descriptions.

LOTOS may be applied to produce a specification of the allowed behaviours of a system, i.e., the set of all behaviours that may be observed of a conforming implementation. Furthermore, LOTOS permits the description of allowed behaviours without describing how this may be achieved or by describing particular mechanisms that achieve the required behaviour.

Formal descriptions of the session service and protocol using LOTOS have been developed:

- TR 9571, *LOTOS Description of the Session Service,* September 1989
- TR 9572, *LOTOS Description of the Session Protocol,* September 1989.

9.4.2.3 SDL

SDL is based (CCITT Z.100-Series recommendations) on the extended finite state machine model supplemented by capabilities for abstract data types based on the initial algebra model (the same one used in the ACT ONE part of LOTOS). This combination is supported by well-defined formal semantics. SDL provides constructs to present structures, behaviours, interfaces, and communications links. In addition, it provides constructs for abstraction, module encapsulation, and refinement. All of these constructs were designed to assist the representation of a variety of telecommunications systems specifications, including aspects of protocols and services.

9.4.2.4 G-LOTOS

Text for a standard for a graphical syntax, G-LOTOS, has been submitted [ISO 8807/PDAM1 1989] that provides an extension to LOTOS (ISO 8807 PDAM1) to facilitate production and enhance clarity and readability of formal descriptions, simplify teaching and learning the language, favour the development of advanced user-friendly

software tools, and promote the diffusion and application of the language [G-LOTOS 1988].[38] AM status is expected in December 1992.

9.4.3 Conformance Test Suites

Before conformance testing can be conducted, conformance test suites must be specified for each standard to be addressed. The standards for conformance test suites typically have two parts: *Test Suite Structure and Test Purposes* and *Abstract Test Suite*. These form the basis for developing a conformance test and verifying its accuracy. Examples of standards for conformance testing are ISO 8882 (X.25), ISO 9594 (Parts X and Y for Directory), DIS 10025 (Transport Protocol), DIS 10168 (Session Protocol), DIS 10169 (ACSE Protocol), ISO 10170 (FTAM), CD xxxx (Transaction Processing Protocol), DIS 10729 (Presentation Protocol), and DIS 10739-1 (Virtual Terminal).

In 1989, NIST conduced an analysis of the OSI testing situation and concluded that unless it acted, no credible means of substantiating GOSIP compliance would be available in time to support the U.S. Government OSI mandate beginning August 1990. Abstract Test Suites, where they existed, were fragmented and not publicly available. Although multiple suppliers of Means of Testing (MOTs) existed, no credible mechanism existed to assess MOTs against GOSIP requirements; no means existed for finding one MOT acceptable and another not. Moreover, no program of evaluating and accrediting commercial GOSIP testing laboratories was planned. From April through November 1989, NIST defined a GOSIP Testing Program and on November 13 issued a proposed *GOSIP Conformance and Interoperation Testing and Registration FIPS* for public comment [Favreau et al. 1990]. On September 30, 1990, NIST published the initial set of registers (*Register of Abstract Test Suites* and *Register of Assessed Means of Testing*). The *Register of Accredited Testing Laboratories* appeared May 1, 1991 [Martin 1991]. Section 7.2.1.1 addresses the POSIX Conformance Test Suite.

9.5 Standards for Registration Authorities

Registration provides unambiguous identification of instances of certain types of information objects within the OSI environment. Examples of these instances are an application process, an application entity, and the definition of a class of information such as a file format. Registration is the assignment of an unambiguous name to an instance of a

[38] New work item [JTC1 N 485] for G-LOTOS was not accepted, but work is proceeding nevertheless (January 1991).

type of information object in a way that makes the assignment available to interested parties. It is carried out by a registration agent that may be either a standard or an organization.

SC21 and SG VII have agreed to collaborate in work on registration authorities. The groups have concurred that "the establishment and operation of registration is critical to communications in a distributed environment and that, without procedures for the operation of registration, interoperability between applications is unlikely" [SC21 N 5014 1990]. An area of disagreement is the presence of the Name Form in DIS 9834-1, included to support the specification of procedures to ensure the assignment of unambiguous names for registration purposes.

ISO JTC1 SC21/WG1 has developed[39] a standard (ISO 9834, *Procedures for the Operation of OSI Registration Authorities*) for the operation of OSI registration authorities. The status and structure of this standard is as follows:

- DIS 9834-1 (Part 1): *General Procedures*, March 1990 [SC21 N 4352]
- ISO 9834-2 (Part 2): *Registration Procedures for Document Types*, November 1990 [SC21 N 5275]
- ISO 9834-3 (Part 3): *Registration of Object Identifier Component Values for Joint ISO/CCITT Use*, July 1990 [SC21 N 4718, April 1990]
- *Register of Object Identifier Components Allocated to Areas for Joint ISO-CCITT Work* [SC21 N 5506, November 1990], maintained as an internal SC21 document
- ISO 9834-4 (Part 4): *Registration of VTE Profiles*, March 1990 [SC21 N 4325]
- ISO 9834-5 (Part 5): *Registration of VT Control Objects*, March 1990 SC21 N 4322]
- DIS 9834-6 (Part 6): *Registration of AP Titles and AE Titles*, September 1990 [SC21 N 5218]

Work on registration authorities (SC21/WG1) is ongoing in one additional area--registration of system titles, but this will probably be incorporated in the management standards. Prior work on authentication mechanisms, application context names, abstract syntaxes, and transfer syntaxes (WD 9834-B, C, D, E, F) is now considered as not required.

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39 Work on Registration Authorities beginning in November 1989 was transferred to SC21/WG6.

9.6 Assessment

Quality of Service and security are not well addressed by OSI and other open systems standards. Both of these sets of services require review and possible modification of the basic reference models for open systems. They therefore could lead to disruption of some of the standards that have already become stable under the existing reference models.

Both sets of services may be supported in a wide range of ways, and several approaches of these may be required in WAM to meet operational requirements. For example, quality of service affects all the layers of the OSI Reference Model, and the associated protocols, managed objects, and parameters of the protocol data units may all have to be extended to meet military requirements. Security can be expected to impact at least the Physical, Network, and Applications Layers of the OSI Reference Model (the NATO position) and other layers as well (SDNS also provides a protocol for the Transport Layer).

Work has already begun on OSI services and protocols in the management area. Support for access control and authentication is already being incorporated into a number of OSI standards. Many other aspects of security, such as key management, still must be standardized to ensure interoperability and to avoid building the same functions many times in similar systems (e.g., function-specific CCISs) and in the applications of a single system, such as WAM.

Management issues can be expected to differ for each of the technologies being considered for WAM. For example, security aspects of local area networks differ from those associated with broadcast radio and packet-switched point-to-point links.

Some issues and findings in security and OSI management are:

- <u>Standards for OSI security are evolving, but the evolution is slow</u>. OSI standards may not be satisfactory in some areas (e.g., OSI services) in and of themselves for military applications. They may need to be supplemented by application-level services outside the OSI model.
- <u>An adequate treatment of management services may require modification to the OSI Basic Reference Model and thereby impact many stable OSI standards</u>.
- <u>Some management standards are now stable</u> (e.g., ISO 9595, ISO 9596; ISO 10040, ISO 10164, DIS 10165), <u>but there is standardization required in many additional areas</u>.

10. USER INTERFACE SERVICE STANDARDS

10.1 Requirements for User Interface Services

User interface services specify the human-computer interface (HCI), terminal management services, and interactions with virtual terminals. Such standard interfaces are needed to ensure a high degree of application portability and to provide a consistent look and feel across multiple implementations.

The user interface services provide a consistent way for applications programs, operating systems, and various system utilities to gain access to the people who develop, administer, and use a system. The WAM Architecture will address not only the technical features of the user interface but also the human engineering considerations. User interface services address client-server operations, object definition and management, window management, and dialog support.

10.2 Standards for User Interface Services

Human-computer interfaces comprise two levels of standardization. One level is the specification of how computer system elements shall interface to display terminals, workstations, and other output devices for which there is capability for human interaction. The second level is the look, feel, and layout of the display screens, keyboards, and other elements of the workstation that would define the way information is displayed and how the user interacts with the information provided. For CCISs, the recommended technical approach is to standardize the interfaces. This is distinct from the military necessity of standardizing information formats and presentations at workstations for operational reasons.

10.2.1 HCI Standards Organizations

The standards work in ISO/IEC covers both levels of HCI. These standards activities seek to:

- Provide consistency--in screen and keyboard layout, terminology, semantics, user action, and syntax--across and within manufacturers, systems, and applications
- Enhance comfort and well-being

- Enhance usability[40]
- Assist in product procurement and evaluation.

Specifically, ISO/IEC JTC1 SC18 (Text and Office Systems) has a working group, WG9 (User System Interfaces and Symbols), that is developing standards to support keyboard layout, user interfaces, cursor control, and icons (e.g., symbols) to be displayed. In addition, the Ergonomics Technical Committee (TC159) of ISO is addressing, through SC4 (Signals and Controls) and WG5 (Software Ergonomics and Man-Machine Dialogue), standards for dialogue interface, coding, formatting, menus, and usability assurance. Other areas of standardization related to the user interface to information systems being addressed by ISO are [Bevan 1989]:

- Documentation (JTC1 SC7/WG2)
- Software quality characteristics (JTC1 SC7/WG3)
- Text interchange (JTC1 SC18/WG4)
- Terminal management (JTC1 SC21/WG4)
- Form Interface Management System (FIMS) (JTC1 SC22)
- POSIX (JTC1 SC22/WG15)
- Commands for interactive text searching (TC46/SC4)
- Software quality assurance (TC176 SC2/WG5).

Other groups working on HCI standards include:

- CCITT Study Group X, Working Party 1, Man-Machine Language
- Human Factors Society, Human Computer Interaction Committee
- ASC X3V1.9, User System Interfaces and Symbols
- IEEE Steering Committee on User Interface
- IEEE Project 1201, Window Interface for User and Application Portability
- Open Software Foundation (OSF)'s Motif Graphical User Interface (GUI)
- Unix International (UI) OPEN LOOK GUI[41]
- Information Industry Association
  - Voice Messaging User Interface Forum (VMUIF)

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40 As used in SC18/WG5, usability of a product is defined as the degree to which specific users can achieve specified goals in a particular environment effectively, efficiently, comfortably, and in an acceptable manner.

41 *Open Look Graphical User Interface: Application Style Guidelines*, by Sun Microsystems, 1990.

- Voice/Fax User Interface Forum (VFUIF) [Reed et al. 1991].

10.2.2 Visual Display Terminal (VDT)

Although work has been underway for several years on the hardware user interface standards, now known and approved as Human Factors Society (HFS)/ANSI 100-1988, Human Factors Engineering of Video Display Terminal Workstation Standard, little work has begun on software user interface standards. The HFS Technical Standards Common Human-Computer Interaction was formed in 1985 to evaluate the feasibility of software user interface standards. It has submitted a fully-reviewed document on menu-based dialogue design to the ISO Working Group on Software Ergonomics (TC159 SC4/WG5) [Reed et al. 1991].

SC18/WG9 seeks to develop a User Interface Standard that would address names of basic objects and actions, user guidance, dialogue interaction, and graphical symbols used on screens. The standard is CD 9995: *Information Technology - Keyboard Layouts for Text and Office Systems*. The current eight parts represent a recombination of material that was formerly presented in 21 parts. The six parts, five of which have been distributed for balloting at the CD level are:

- CD 9995-1, *General Principles Governing Keyboard Layouts*
- CD 9995-2, *Alphanumeric Section*
- CD 9995-3, *Common Secondary Layout of Alphanumeric Zone of Alphanumeric Section*
- DP 9995-4, *Principles Governing the Placement of Characters and Symbols on Keys*
- CD 9995-5, *Editing Section*
- CD 9995-6, *Functional Section*
- CD 9995-7, *Symbols Used to Represent Functions.*

WG 9 has also distributed working drafts of two components of an as-yet unnumbered standard for icons used on screens. The standard is intended to apply to systems implementing the desktop metaphor, although icons systems suitable for other application fields may be future subjects of standardization [Billingsley 1990]. ASC X3V1.9 is the U.S. Technical Advisory Group to WG9.

TC159 SC4/WG5 is developing a standard (ISO 9241) for VDTs that addresses office task requirements, visual requirements, keyboard ergonomics, work place design and environment, surfaces and filters, use of color and graphics, non-keyboard input

devices, usability, coding, formatting, and terminology. The status of the standards in ISO 9241, *Ergonomic Requirements for Office Work with Visual Display Terminals*, is as follows:

- ISO 9241-1, *Introduction*
- ISO 9241-2, *Task Requirements*
- DIS 9241-3, *Visual Display Requirements*
- DIS 9241-4, *Keyboard Requirements*
- CD 9241-5, *Workstation Layout and Postural Requirements*
- CD 9241-6, *Environmental Requirements*
- CD 9241-7, *Display Requirements with Reflections*
- CD 9241-8, *Requirements for Displayed Colors*
- CD 9241-9, *Requirements for Non-Keyboard Input Devices*
- WD 9241-10, *Dialogue Principles*
- CD 9241-11, *Usability Statements*
- CD 9241-12, *Presentation of Information*
- WD 9241-13, *User Guidance*
- CD 9241-14, *Menu Dialogues*
- WD 9241-15, *Command Dialogues*
- WD 9241-16, *Direct Manipulation Dialogues*
- WD 9241-17, *Form-Filling Dialogues*
- XX 9241-18, *Question and Answer Dialogues* (not yet started)
- XX 9241-19, *Natural Language Dialogues* (not yet started).

10.2.3 Virtual Terminal (VT)

VT standards (ISO 9040 and 9041) define a communications protocol between a terminal and its host in terms of a conceptual terminal, where the mapping from the conceptual terminal to the physical device is an implementation issue outside the standard. Several classes of display and data manipulation capabilities will eventually be addressed by VT standards [OSN 1989b]:

- Basic class, for textual data in a rectangular array of character boxes
- Forms class, similar to the basic class, but with the ability to define fields with control over data entry

- Graphics class, for geometric data such as lines and circles (as defined, for example, in GKS)
- Text class, for structured data such as provided by ODA data streams
- Image class, for bit-mapped displays.

The initial VT standards address the basic class of capabilities. They will contain addenda that provide extensions (AD1, *Extended Facility Set*) to the basic class for enhanced access rules, structured control objects, blocks, fields, and reference information objects. These enhancements will be incorporated into the base text before the standards are submitted for ballot as international standards. Three additional extensions are being developed [SC21 N 3366 and N 3367, December 1988] for VT: ripple, to provide facilities to undertake simple text editing by the addition of control objects and operations; exception reporting for non-fatal errors; and context retention for multiple VT sessions. These extensions have been progressed as Addendum 2 (AM2, *Additional Functional Units*) to both ISO 9040 and 9041. DIS 9041-2, *VT PICS Proforma* [SC21 N 5702], is being developed. An editing meeting is scheduled for November 1991. SC21/WG5 expects to reach IS status for the PICS Proforma in February 1992. In addition, registration authority procedures have been developed for the Virtual Terminal Environment (VTE) and VT Control Objects: ISO 9834-4 and ISO 9834-5, respectively. Finally, a guide to VT standards has been developed by SC21/WG5 [SC21 N 3365, December 1988]. A draft international standard *Conformance Test Suite for the VT Protocol* (DIS 10739-1) has also been developed. This is expected to become a standard in July 1992.

DAM2 [SC21 N 5030 and N 5031, May 1990] for ISO 9040/9041 enhances the capability of the VTE by use of the Association Establishment or Negotiation functions, extends the set of objects and operations provided by the Data Transfer function, and enhances error handling capabilities of the service provider. DAM2 provides additional functionality for ripple mode editing (insertion, deletion, and copy operations for a Display Object), exception reporting (provides mechanisms by which non-fatal exception conditions may be reported by the VT service provider to both VT users), and retention of VT context across Negotiation (retention of the information stored in selected VT Objects--Display Object and Control Objects--to be retained between successive VT environments within the life time of a VT association).

VT profiles are being developed by two regional workshops: the EWOS and the NIST OSI Implementor's Workshop. EWOS is working on synchronous-mode profiles that are based on a two-way exchange with a single display object requiring the exchange

of an access token. EWOS profiles include Forms, Page, Enhanced, and Enhanced Page. The NOIW is developing asynchronous-mode profiles. These are based on a character-by-character interworking, in which there are two display objects, but the user at each end is allowed to update only one of the objects. NOIW profiles include TELNET, Transparent, Forms, Scroll, Page, and X29 (of which the first three are in the Stable Agreements).

10.2.4 Terminal Management (TM)

SC21/WG5 is working on a program for developing standards for TM, directed at support for multi-function workstations. The role of TM is to support the control and manipulation of logical devices typically associated with workstations. Logical devices are defined in TM to provide a mapping between transferred data such as ODA documents and the physical devices such as a workstation screen, taking into account control information such as synchronization and the use policy of a particular application. TM is related to Document Transfer and Manipulation (DTAM, CCITT), user interface standards (SC18), Forms Interface Management System (FIMS, SC22), and window management (SC24). The TM standard consists of three parts: *TM Model* (CD 10184-1), *TM Service* (WD 10184-2), and *TM Protocol* (WD 10184-3). The first, *TM Model*, progressed to CD status in June 1990 [SC21 N 4188 1989] and is expected to progress to DIS in July 1992 and IS in July 1993. CD status for the other two is expected in July 1992, DIS in December 1992, and IS in December 1993.

TM provides a general framework for defining interactive processes that support in a systematic way such diverse features as: (1) combining different data types (e.g., presenting diagrams with a telephone conversation); (2) handling multiple simultaneous dialogues from a single terminal; and (3) interacting with several levels of processes in a single session, in which low-level functions such as echoing and simple checking are done locally, and responses to more demanding operations such as database access are generated by a remote system. The TM draft standards address the following requirements [SC21 N 4176 1989]:

- Presenting data from several sources on a single display, for example using a window system.
- Moving data between windows presented together.
- Supporting multiple users and displays attached to one application.
- Handling the same data at several different levels of abstraction; for example, a graphics image may need to be manipulated at the level of a display list, at the level of various geometric objects, or at the bit-map level.

- Controlling how the logical structure of dialogues is mapped onto real resources, such as open systems and OSI application associations.

TM permits the establishment of a general network of processes with dialogues between them. The dialogues may be of a variety of types, such as VT, bit-map graphics, or ODA. TM does not itself define the operation of an individual process, nor does TM define the data stream for a particular dialogue type--these are specified by other standards. Where a process has input parameters that may be adjusted, such as the specification of the positions and priorities of the various windows in a window system, these are provided by TM. The TM model addresses the following:

- Model for Terminal Management Application Service Elements (ASEs) in two or more open systems that collectively are defined as a Terminal Management Domain (TMD)
- Model for the information flows between ASEs within a TMD
- Model for the shared use of interactive resources within a TMD
- Mechanisms for the representation of information in a window environment
- Relationships between the Terminal Management ASE and other ASEs within a Single Association Control Function
- Relationship between the Terminal Management ASEs and other ASEs within the Multiple Association Control Function.

A User Descriptor Object (UDO) is defined in TM; the UDO is updated and maintained by a TM control process within a TM domain. The UDO supports the following mechanisms and requirements:

- End-user specific libraries
- User Interface Management System (UIMS) tool kits
- Local system characteristics such as devices supported, window management system information in support of specific menus and icons, peripherals to be supported during a given instance of communication, and a user clipboard for the storage of miscellaneous information
- Application-specific information (known to the user)
- Window management system and user interface dependencies, such as sizing a user interface to fit window instructions
- State information for devices supported, UIMS in general, and active and deactivated applications.

TM contains a User Window Manager Interface onto which users may interface their own window manager. If a user-supplied window manager is in place, all user requests are first sent to the user window manager. In cases where the user window manager makes decisions in conflict with the TM domain user policy, these are resolved within the TM process.

10.2.5 Status of X-Windows

The X-Windows standard effort, a UNIX-based user interface standard, began as a *de facto* standard developed at the Massachusetts Institute of Technology (MIT). It was developed by Project Athena and the Laboratory for Computer Science at MIT with funding and participation by Digital Equipment Corporation (DEC) and IBM [McCartney 1987]. Currently in Version 11 (Release 3), X-Windows sets a standard to provide portability of information across different hardware and operating systems. In contrast to the kernel-based architecture of traditional windowing systems, it has a network-based architecture. *User Interface* is based on this standard as is *DEC windows* software from DEC [Stoffel 1989; Oldenburg 1989].

The strategic direction in ISO for OSI support of windowing environments is Terminal Management. However, there is a rapidly growing demand for the use of the X-Windows system. This demand is being satisfied by the use of X-Windows clients and servers co-located in the same machine or over LANs using protocols such as TCP/IP. Some large user communities are now trying to run X-Windows over WANs and in some cases may plan to install TCP/IP networks in competition with the emerging OSI networks based on ISO protocols [SC21 N 4189 1989].

An efficient OSI compatible way of supporting the X-Windows System in an OSI environment is needed. While it would be preferable from the standards point of view to rewrite X-Windows completely, removing the session and presentation functionality it concurrently contains, this would require developmental effort and dedicated expertise that does not appear to be available. Further, by the time any such standard becomes complete, it would likely be too late to gain acceptance. Instead, on April 21, 1991, X3 announced the approval of a new project on X Window System Data Stream Definition, Part IV: Mapping onto Open Systems Interconnection (OSI) Services. This draft standard, under development by Technical Committee X3H3, Computer Graphics, represents the development of the Version 11 of X-Windows (X11) mapping onto OSI services. This mapping entails the use of the OSI Application Layer, employing the ACSE for association establishment and release and P-Data from the Presentation Layer for transmission of the X

data stream encoding. OSI Application Layer naming and addressing conventions will be used [X3 1991i].

Because X11 has limited two-dimensional (2D) graphics capabilities, a consortium of organizations under the auspices of MIT has developed X3D-PEX, an extension to the X11 standard that supports the Programmers' Hierarchical Interactive Graphics System (PHIGS) and the three-dimensional version of the Graphical Kernel System (GKS-3D) [Clifford et al. 1988]. PHIGS and GKS are discussed in Section 4.2.2.

Despite competition from other UNIX-based windowing systems like Sun Microsystems' *News*, *Silicon Graphics*, *4Sight*, and Carnegie-Mellon's *Andrew* [Greco 1988], X-Windows has received rapid and overwhelming acceptance as an industry standard [Anderson 1989]. X-Windows is the subject of NIST, IEEE, and ANSI standards projects. FIPS-158, *X-Window User Interface,* was approved in May 1990 as a U.S. mandatory standard.

10.2.6 User Interface Reference Models

FIPS-158 comprises the first three layers (Layers 0-2) of the User Interface Reference Model developed by NIST [Kuhn 1990]. The NIST Model consists of:

- Layer 0: Data Stream Encoding
- Layer 1: Data Stream Interface (Xlib)
- Layer 2: Subroutine Foundation (Xt Intrinsics)
- Layer 3: Toolkit
- Layer 4: Dialogue
- Layer 5: Presentation
- Layer 6: Application.

Layer 0 is an X- Protocol for messages between client and server. It equates with ANSI X3H3.6 (Window Management) Project 0672-D, "X Data-Stream Encoding for Window Management X Window System VII Data Stream Definition." The target date for completion of this standard is the second quarter of 1991. Layer 1 is a library interface that provides a C language interface to the X-Protocol. Layer 2 consists of basic functions for controlling windows and acts as a tool kit for building tool kits [Kuhn 1990].

An IEEE P1201 Reference Model, which is built on the NIST Reference Model, relates X, 1201 work, and other systems. IEEE Project P1201.4, "X Library" is Layer 1

of the NIST Model. Xt Intrinsics (Layer 2 from the NIST Model above) may be taken on by IEEE P1201, but a formal proposal has not yet been made for this work.

NIST Reference Model Layers 3 through 5, while not part of FIPS-158, are the subject of IEEE projects. Layer 3 is equivalent to IEEE Project 1201.1, "Toolkit--High-Level Windowing Applications Program Interface." IEEE P1201.1 is also developing a framework for interfaces for user and application portability. The toolkit layer is implemented using a collection of widgets. Several different widget sets may be used. Some of the earliest were released by MIT's Project Athena (where X was originally developed), Hewlett-Packard, and DEC. Today, the most popular widget sets are OSF's MOTIF and AT&T's OPEN LOOK. By definition, the widget layer not only provides an API, but also presents a certain look and feel to users that varies among widget sets. Much of the work of the P1201 API group thus far has been devoted to deciding whether the working draft of the API standard should be based on OPEN LOOK or MOTIF, or whether a combined approach should be taken [Mehta 1990].

Layers 4 and 5 are addressed respectively by the User Interface Language and UIMS work of IEEE Project 1201.3 and are still in the research stage. IEEE has formed a study group, but not a working group, for this work.

The GUI is part of the IEEE P1201 Reference Model but is not included in the NIST Reference Model. The GUI is the subject of IEEE Project 1201.2, "Drivability Guide," which provides a recommended practice for minimal commonality for window systems (see Section 3.4.3.3). It uses the analogy of controls for driving a car [Kuhn 1991]. A pre-draft was issued in March 1991; the standard is expected to go to ballot in the last quarter of 1992 [Martin 1990a].

10.2.7 OSF/MOTIF

The OSF/Motif GUI is the result of OSF's RFT process which solicited input from the worldwide computer industry for GUI technology. OSF/Motif was first released in July 1989 and incorporates technologies from Digital Equipment Corporation, Hewlett-Packard, and Microsoft. It is currently in Release 1.1.

OSF/Motif offers user-oriented PC-style behavior and screen appearance for applications running on any system which can support X-Windows System, Version 11, Release 3 or 4. It comprises an API consisting of a toolkit and User Interface Language (UIL). In addition, its window manager offers a standard environment for manipulating application windows. The OSF/Motif environment provides Native Language Support

(NLS) consistent with the NLS solution proposed in the X/OPEN XPG3. The UIL can fully support display of 16-bit and compound strings, including all character sets standardized by the X Consortium, to provide localization in Asian and European languages [OSF 1990a].

In addition to being under consideration by P1201 as the basis for an API standard, the DoD CIM standards office is also considering OSF/Motif as an interim DoD GUI standard.

10.2.8 OPEN LOOK

OPEN LOOK, jointly developed by Sun Microsystems and AT&T is another implementation-independent GUI specification. Three toolkits can be used with OPEN LOOK:

- News Development Environment (NDE) (Sun) is an emulated PostScript interpreter modified to suspect a windowing system
- XView (Sun) implements OPEN LOOK on top of the Xlib level of the X-Window System
- Xtt (AT&T) is built upon the intrinsics level of the X-Window System.

The choice of toolkit depends, in part, on the target platform to be used: NDE and XView for the Sun, XView for DEC VAX, and Xtt for AT&T platforms. These toolkits are proprietary to Sun and AT&T, unlike the OSF/Motif toolkit. Also, unlike OSF/Motif, OPEN LOOK implementations are currently limited to eight-byte character sets and are English-based. OPEN LOOK presently receives less industry support than OSF/Motif.

10.3 Assessment

Of all the service groups, standards for the user interface services are the least mature. This area suffers from a general lack of standards for toolkits and UIMS and at the API level itself. API directions likely to be taken over the next 5-10 years are uncertain. GUIs remain in the research stage. Standards for window management are only emerging. Neither Terminal Management (TM) nor X-Windows has reached the stage of becoming an international standard. TM has the support of ISO but its progress is slow. X-Windows has wide support in the United States and elsewhere, but the implementations are not standardized. Some issues are:

- Is there a requirement in WAM to establish a common look and feel for user interfaces? Does such a requirement come from the functional requirements, the training requirements, or from the users as a separate operational requirement?
- Is it appropriate to adopt a *de facto* standard, such as one set of X-Window interfaces, for WAM? The user interface services area may be one case in which *de facto* standards must be used in lieu of international standardization.

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ACRONYMS

4GL	Fourth Generation Language
APTL	Accredited POSIX Testing Laboratories
A	Application (profile)
AC	Armament Committee (NATO)
ACBA	Allied Command Baltic Approaches
ACC	Access Control Center (U.S. DoD, BLACKER)
ACCIS	Automated Command and Control Information System
ACCS	Air Command and Control System
ACE	Allied Command Europe
ACIS	Access Control Information System (SDNS)
ACK	Acknowledgement
ACM	Association for Computing Machinery
ACP	Allied Communications Publication
ACSE	Association Control Service Element (OSI Layer 7)
AD	Addendum (ISO)
ADatP	Allied Data Publication
ADCCP	Advanced Data Communications Control Procedures (ANSI X3.66)
ADI	Directory Application (ISP)
ADMD	Administration Management Domain
ADP	Automated (Automatic) Data Processing
ADS	Automated Data System
ADSIA	Allied Data Systems Interoperability Agency
AE	Application Element
AEP	Application Environment Profile (POSIX)
AFCENT	Allied Forces Central Europe
AFNOR	Association Francaise de Normalisation (France)
AHWG	Ad Hoc Working Group
AHWG-FP	Ad Hoc Working Group on Functional Profiles (TSGCE SG9)
AHWG-OM	Ad Hoc Working Group on OSI Management (TSGCE SG9)
AI	Artificial Intelligence
AIE	Ada Integrated Environment (Air Force)
AJPO	Ada Joint Program Office
ALF	Application-Level Facility (ATCCIS)
ALS	Application Layer Structure (OSI)
ALS	Ada Language System (Army)
AM	ACE Manual

ANCA	Allied Naval Communications Agency (NATO)
ANS	ANSI National Standard (United States)
ANSI	American National Standards Institute
AO	Accredited Organization (ANSI)
AOW	Asia-Oceania Workshop (Sponsored by POSI)
APDU	Application Program Data Unit
API	Applications Programming Interface
APP	Applications Portability Profile (NIST)
APSE	Ada Programming Support Environment
APTL	Accredited POSIX Testing Laboratories (NIST)
AR	U.S. Army Regulation
ARPANET	Advanced Research Projects Agency Network (United States)
AS	Accredited Sponsor (ANSI)
ASC	Accredited Standards Committee (ANSI)
ASCII	American National Standard Code for Information Interchange
ASE	Application Service Element (OSI)
ASME	American Society for Mechanical Engineers
ASN	Abstract Syntax Notation (OSI)
ASN.1	Abstract Syntax Notation One
ASO	Application Service Object (OSI)
ATACC	Advanced Tactical Air Command Central (U.S. DoD)
ATCA	Allied Tactical Communications Agency (NATO)
ATCCIS	Army Tactical Command and Control Information System
ATCCS	U.S. Army Tactical Command and Control System
ATIS	A Tools Integration Standard
ATLR	Active Transport Layer Relay
ATOC	Allied Tactical Operations Centre
ATP	Allied Tactical Publication
ATS	Abstract Test Suite
AUTODIN	Automatic Digital Network (U.S. DoD)
AVI	Audio Visual Interactive Scriptware (JTC 1)
AWHQ	Alternate War Headquarters
B	ISDN B Service (64 kbit/second)
BASE	Baseband
BER	Basic Encoding Rules (ASN.1)
BFA	Battlefield Functional Area
BFE	BLACKER Front End (U.S. DoD)
BICES	Battlefield Information Collection and Exploitation Systems
BIH	Bureau International de l' Heure (France)
BISDN	Broadband ISDN

BROAD	Broadband
BSD	Berkeley System Definition (Unix)
BSI	British Standards Institute (United Kingdom)
C2	Command and Control
CAD	Computer Aided Design
CAE	Common Applications Environment (X/Open)
CAIS	Common APSE Interface Set
CALS	Computer Acquisitions and Logistics Support (United States)
CAM	Computer Aided Manufacturing
CASE	Common Application Service Elements (OSI Layer 7)
CASE	Computer-Aided Software Engineering
CBEMA	Computer and Business Equipment Manufacturers Association (United States)
CCIR	Comite Consultatif International de Radio (International Radio Consultative Committee)
CCIS	Command and Control Information System
CCITT	Comite Consultatif International de Telegraphique et Telephonique (International Telegraph and Telephone Consultative Committee)
CCR	Commitment, Concurrency, and Recovery (OSI Layer 7)
CCS	Calculus of Communicating Systems (LOTOS)
CCSDS	Consultative Committee on Space Data Systems
CD	Committee Draft (ISO)
CD-ROM	Compact Disk Read Only Memory
CDAD	Committee Draft Addendum
CDAM	Committee Draft Amendment
CDIF	CASE Data Interchange Format
CDTR	Committee Draft Technical Report
CEC	Commission of the European Community
CEDD	Committee for the Exchange of Digital Data (IHO)
CEN	Comite Europeen de Normalisation (European Committee for Standardization)
CENELEC	Comite Europeen de Normalisation Electrotechnique (European Committee for Electrotechnical Standardization)
CEPT	Conference Europeenne des Postes et Telecommunications
CER	Confidential Encoding Rules (ASN.1)
CGI	Computer Graphics Interface (Interfacing)
CGM	Computer Graphics Metafile
CGMIF	Computer Graphics Metafile Interchange Format
CG-VDI	Computer Graphics Virtual Device Interface
CHILL	CCITT High Level Language
CIEG	Common Information Exchange Glossary
CIGOS	Canadian Interest Group on Open Systems

CIGREF	Club Informatique des Grandes Enterprises Francaises (France)
CIA	CASE Integration Services
CIM	Corporate Information Management (U.S. DoD initiative)
CIM	Center for Information Management (DISA)
CIS	CASE Integration Services Committee
CL	Connectionless (mode)
CLID	Common Language-Independent Data Types
CLIP	Common Language-Independent Procedure Calling Mechanisms
CLIPCM	Common Language-Independent Procedure Calling Mechanisms
CLNP	Connectionless Network Protocol (OSI)
CLNS	Connectionless Network Service (OSI)
CLTS	Connectionless Transport Service (OSI)
CMIP	Common Management Information Protocol (OSI)
CMIS	Common Management Information Service (OSI)
CNAD	Conference of National Armaments Directors (NATO)
CO	Connection Oriented (mode)
COLOC	Change of Location of Command
COMPUSEC	Computer Security
CONS	Connection-Oriented Network Service (OSI)
COS	Corporation for Open Systems
COSINE	Corporation for Open Systems Interconnection Networking in Europe (COSINE)
COTS	Connection-Oriented Transport Service (OSI); Commercial Off-the-Shelf
CR	Central Region (NATO)
CSA	Canadian Standards Association
CSDN	Circuit Switched Data Network
CSL	Computer Systems Laboratory (NIST)
CSMA/CD	Carrier Sense Multiple Access/Collision Detection
CSN	Circuit Switched Network
CSNI	Communications System/Network Interoperability
CSP	Communicating Sequential Processes (LOTOS)
CSPDN	Circuit Switched Public Data Network
CTS	Conformance Testing Services (CEN/CENELEC)
CTS-WAN	Conformance Testing Services-Wide Area Network
CUA	Common User Access (IBM)
D	ISDN D Service (16 kbit/second)
DAD	Draft Addendum (ISO)
DAF	Framework for the Support of Distributed Applications (CCITT)
DAFTG	Database Architecture Framework Task Group (ANSI)
DAM	Draft Amendment (ISO)

DAO	Document Architecture Operations
DAP	Document Application Profile
DARPA	Defense Advanced Research Projects Agency (U.S. DoD)
DBMS	Database Management System
DCA	Defense Communications Agency (See DISA)
DCE	Data Circuit-Terminating Equipment
DCF	Data Communication Function
DCPS	Data Communications Protocol Standards
DCT	Digital Communications Terminal (U.S. DoD)
DCW	Digital Chart of the World
DDL	Data Definition Language
DDN	Defense Data Network (U.S. DoD)
DEC	Digital Equipment Corporation
DER	Distinguished Encoding Rules (ASN.1)
DFR	Document Filing and Retrieval
DGIWG	Digital Geographic Information Working Group
DIB	Directory Information Base
DID	Data Item Descriptors
DIGEST	Digital Geographic Information Exchange Standard
DIN	Deutsches Institut fur Normung (Federal Republic of Germany)
DIR	Directory
DIS	Draft International Standard (ISO)
DISA	Defense Information Systems Agency (U.S. DoD, formerly DCA)
DISNET	Defense Integrated Secure Network (U.S. DoD)
DISP	Draft International Standardized Profile
DIT	Directory Information Tree
DMA	Defense Mapping Agency (U.S. DoD)
DME	Distributed Management Environment (OSF)
DMF	Data Management Facility (ATCCIS)
DML	Data Manipulation Language
DMRM	Data Management Reference Model
DMS	Data Management Subsystem (ACE CCISs); Defense Message System (U.S. DoD)
DMS	Defense Message System (U.S. DoD)
DNS	Domain Name System (U.S. DoD)
DOA	Distributed Office Application
DOAM	Distributed Office Applications Model
DoD	Department of Defense (United States)
DoD-STD	DoD Standard
DoDCSC	U.S. Department of Defense Computer Security Center
DoDISS	DoD Index of Standards and Specifications
DP	Draft Proposal (ISO)

DPA	Document Printing Application
DPS	Digital Production System (DMA)
DQDB	Distributed Queue Dual Bus (local area network)
DQSO	Defense Quality Standardization Office
DSA	Directory System Agents
DSG	Distributed System Gateway
DSSSL	Document Style Segmentation and Specification Language
DTAM	Document Transfer and Manipulation
DTD	Document Type Definition
DTED	Digital Terrain Elevation Data
DTMP	DCPS Technical Management Panel (U.S. DoD)
DTE	Data Terminal Equipment
DTP	Distributed Transaction Processing
DTR	Draft Technical Report (ISO)
DVI	Digital Video Interactive
E-Mail	Electronic Mail
EC	European Community
ECCM	Electronic Counter-Countermeasures
ECMA	European Computer Manufacturers Association
ECITC	European Committee for IT Testing and Certification
ED&C	Error Detection and Correction
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce, and Transport
EESP	End-to-End Security Protocol
EFTA	European Free Trading Association
EG	Expert Groups (NIST OSI Implementor's Workshop)
EGTP	Expert Group on Transaction Processing (EWOS)
EIA	Electronic Industries Association
EMUG	European Manufacturing Automation Program (MAP) User Group
EN	European Norm (European Standard) (CEN/CENELEC)
ENV	European Norm Vornorm (European Experimental Standard) (CEN/CENELEC)
EPA	Environmental Protection Agency (United States)
EPHOS	European Procurement Handbook for Open Systems
ES-IS	End System to Intermediate System
ESPRIT	European Strategic Programme of Research and Development in Information Technology
ETSI	European Telecommunications Standards Institute
EUROCOM	Eurogroup on Cooperation of Tactical Communications Systems
EWOS	European Workshop for Open Systems

FACC	Feature Attribute Coding Catalog
FCS	Frame Check Sequence
FD	Formal Description
FDDI	Fiber Distributed Data Interface
FDT	Formal Description Technique
FEC	Forward Error Correction
FFOL	FDDI Follow-On LAN
FIMS	Forms Interface Management System
FIPS	Federal Information Processing Standard (United States)
FOD	Office Document Format
FOIRL	Fiber Optic Inter-Repeater Link
FORMETS	Message Text Formatting System (NATO)
FORTRAN	Formula Translation (programming language)
FRP90	Frigate Replacement Program for the 1990s (NATO)
FSSG	Fire Support Subgroup (JTC3A)
FTAM	File Transfer, Access and Management (OSI Layer 7)
FTP	File Transfer Protocol (U.S. DoD)
FUI	Flow (Control) Unnumbered Information
GAN	Global Area Network
GDMI	Generic Definition of Management Information (OSI)
GEADGE	German Air Defense Ground Environment
GIF	Graphics Interchange Format
GIS	Geographic Information System
GKS	Graphical Kernel System
GKS-3D	Graphical Kernel System for Three Dimensions
GOSIP	Government Open Systems Interconnection Profile
GSTN	General Switched Telephone Network
GUI	Graphical User Interface
HCI	Human-Computer Interface
HD	Harmonized Document (CEN/CENELEC)
HDLC	High-Level Data Link Control (OSI Layer 2)
HDTV	High Definition Television
HEROS	Heeres-Fuehrungsinformationssystem fur die rechnergestuetzte Operations- fuehrung in Staeben
HFS	Human Factors Society
HUI	Human Interface
IAB	Internet Activities Board (US DoD)
IAP	Interfaces for Applications Portability (ISO/IEC JTC1)
IBN	Institut Belge de Normalisation (Belgium)

ICSI	International Coding System Identifier
ICS	Implementation Conformance Statement
ICT	Intercept Recommendation (TSGCE SG9)
ID	Identification
IDN	Interface Definition Notation (ECMA 127)
IEC	International Electrotechnical Commission
IEE	Institution of Electrical Engineers (United Kingdom)
IEEE	Institute of Electrical and Electronics Engineers (United States)
IEPG	Independent European Programme Group (NATO)
IER	Information Exchange Requirement
IFF	Interchange File Format
IFIP	International Federation for Information Processing
IFRB	International Frequency Registration Board (UIT)
IFU	Interworking Functional Unit
IGES	Initial Graphics Exchange Specification
IHO	International Hydrographic Organization
IIRS	Institute for Industrial Research and Standards (Ireland)
IJMS	Interim JTIDS Message Standard
INSTAC	Information Technology Standardization Technology Committee
INTAP	Interoperability Technology Association for Information Processing (Japan)
IOF	Input-Output Facility (ATCCIS)
IP	Internet Protocol; Interoperability Parameter; Internetwork Protocol
IPM	Interpersonal Messaging (MHS Service)
IRD	Information Resource Dictionary
IRDS	Information Resource Dictionary System
IS	International Standard (ISO); Intermediate System (OSI)
ISAM	Indexed Sequential Access Method
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization; International Standard
ISODE	ISO Development Environment
ISP	International Standardized Profile
ISWG	Information Systems Working Group
ITDN	Integrated Tactical-Strategic Digital Network (U.S. DoD)
ITI	Industrial Technology Institute
ITS	Integrated Tool Set (COS)
ITSTC	Information Technology Steering Technical Committee (U.K.)
ITSEC	Information Technology Security Evaluation Criteria
ITU	International Telecommunications Union
IUKADGE	Improved United Kingdom Air Defence Ground Environment

IVD	Integrated Voice and Data (local area network)
IWF	Interworking Function
IWU	Interworking Unit (OSI for relay functional profiles)
JBIG	Joint Bi-Level Imaging Group
JINTACCS	Joint Interoperability of Tactical Command and Control Systems (US DoD)
JIS	Japanese Industrial Standard
JISC	Japanese Industrial Standards Committee
JMSWG	Joint Messaged Standards Working Group (JTC3A)
JPEG	Joint Photographic Experts Group
JSA	Japanese Standards Association
JTAP	JTC1 TAG Applications Portability Study Group
JTC1	Joint Technical Committee One (ISO/IEC)
JTM	Job Transfer and Manipulation (OSI Layer 7)
JTSSG	Joint Technical Standards Steering Group (DoD)
KAPSE	Kernel Ada Programming Support Environment
KBS	Knowledge Based Systems
KDC	Key Distribution Center (BLACKER)
KIT	KAPSE Interface Team
KITIA	KAPSE Interface Team from Industry and Academia
KMAE	Key Management Application Entity
KMAP	Key Management Application Process
KMASE	Key Management Application Service Element
LAN	Local Area Network
LAP B	Link Access Procedure, Balanced
LAP D	Link Access Procedure, Version D (used for ISDN)
LCAS	Language Compatible Arithmetic Standard
LLC	Logical Link Control (OSI Network Layer)
LOCE	Limited Operational Capability-Europe
LOTOS	Language of Temporal Ordering of Specification
LTDP	Long-Term Defence Plan
MAC	Media Access Control
MACF	Multiple Association Control Function
MAN	Metropolitan Area Network
MAP	Manufacturing Automation Protocol
MAPSE	Minimum Ada Programming Support Environment
MAS	Military Agency for Standardization
MCS	Maneuver Control System (US Army)

MF	Mediation Function
MHEG	Multimedia and Hypermedia information coding Experts Group
MHS	Message Handling System (OSI Layer 7)
MIA	Multivendor Integration Architecture
MIB	Management Information Base
MIDLA	Media-Independent Data Link Architecture (TSGCE)
MIDS	Multinational Information Distribution System (NATO)
MIL-STD	Military Standard (US DoD)
MILNET	Military Network (United States)
MIPS	Management Information Protocol Specification (see CMIP)
MIS	Management Information Service (OSI); Management Information System
MISD	Management Information Service Definition (see CMIS)
MIT	Massachusetts Institute of Technology
MITI	Ministry of International Trade and Industry (Japan)
MM	Mixed Mode (of Operations in DTAM)
MMHS	Military Message Handling System (see CCITT X.400-1988)
MMI	Man-Machine Interface
MML	Man-Machine Language (CCITT Z.300 Series)
MMS	Manufacturing Message Specification (MAP)
MNC	Major NATO Command
MOCS	Managed Object Conformance Statement
MOD	Ministry of Defence (United Kingdom)
MO:DCA	Mixed Object Document Content Architecture
MOT	Means of Testing
MOTIS	Message-Oriented Text Interchange System (OSI Layer 7)
MPC	Multi Party Communications
MPDT	Multipeer Data Transmission (OSI)
MPEG	Moving Pictures Expert Group
MPTM	Multi-party Test Methods
MS	Message Store (MHS)
MSC	Major Subordinate Command (NATO)
MSDSG	Multi-System Distributed System Gateway
MSE	Mobile Subscriber Element (U.S. Army)
MSP	Message Security Protocol (SDNS)
MT	Message Transfer
MTA	Message Transfer Agent (MHS)
MTF	Message Text Formats
MTS	Marine Tactical Systems (U.S. DoD)

N	Notice (ISO Working Paper)
NACISA	NATO Communications and Information Systems Agency
NACISC	NATO Communications and Information Systems Committee
NACISO	NATO Communications and Information Systems Organization
NAEW	NATO Airborne Early Warning
NBS	US National Bureau of Standards (now NIST)
NBSIR	NBS Interim Report
NCC	National Computing Centre
NCIS	NATO Common Interoperability Standards
NCISI	Non-Contact Information Systems Interface
NCS	Network Computing Services
NCS	National Communications System (U.S. DoD)
NCSL	National Computer Systems Laboratory (NIST)
NDE	News Development Environment (Sun Microsystems)
NDI	Nondevelopmental Item
NDL	Network Database Language (OSI)
NEC	Northern European Command
NEF	Network Element Function
NET	Telecommunications European Norm
NFR90	NATO Frigate Replacement for the 1990s
NFS	Network File Service
NIAG	NATO Industrial Advisory Group
NIDL	Network Interface Definition Language
NIIF	Network Independent Interface (NIAG SG6)
NIIS	NATO Interconnected Information System
NILS	Network Internal Layer Structure
NIMP	NATO Interoperability Management Plan
NIPD	NATO Interoperability Planning Document
NIS	NATO Identification System
NIST	U.S. National Institute of Standards and Technology
NLR	Network Layer Relay
NLS	Native Language Support (X/Open)
NM	Network Management
NMOS	NATO Maritime Operational Intelligence Support
NMSIG	Network Management Special Interest Group (NIST OSI Implementor's Workshop)
NNI	Nederlands Normalisatie-Instituut (Netherlands)
NOIW	NIST OSI Implementor's Workshop
NOSA	NATO OSI Security Architecture
NP	New Project (ISO, formerly New Work Item)
NPDU	Network Protocol Data Unit
NPICS	NATO Protocol Implementation Conformance Statement

NPS	Nuclear Planning System
NSA	National Security Agency (United States)
NSAI	National Standards Authority of Ireland
NSAP	Network Service Access Point (OSI)
NSS	National Standards System (Canada)
NTIS	NATO Technical Interoperability Standards
NTIS	National Technical Information Service (United States)
NTP	Network Time Protocol
NTT	Nippon Telegraph and Telephone Corporation (Japan)
NVLAP	National Voluntary Laboratory Accrediation Program (NIST)
NWI	New Work Item (ISO) (see also NP)
ODA	Office Document Architecture
ODAC	Office Document Architecture Consortium
ODIF	Office Document Interchange Format
ODL	Office Document Language
ODP	Open Distributed Processing
OM	OSI Management
OS	Operating System
OS/2	Operating System 2 (IBM)
OSCRL	Operating System Command and Response Language
OSD	Office of the Secretary of Defense (U.S. DoD)
OSE	Open System Environment
OSF	Open Software Foundation
OSI	Open Systems Interconnection
OSITP	OSI Transaction Processing
OSITOP	Open Systems Interconnection for Technical and Office Protocol
OSN	Open Systems Newsletter
OSTC	Open Systems Testing Consortium
PAD	Packet Assembly/Disassembly
PAR	Project Authorization Request (IEEE)
PCDAM	Proposed Committee Draft Amendment (ISO)
PCIS	Portable Common Interface Set
PCTE	Portable Common Tool Environment
PCTS	POSIX Conformance Test Suite
PDAD	Proposed Draft Addendum (ISO)
PDAM	Proposed Draft Amendment (ISO)
PDES	Product Definition Exchange Specification
PDIF	Product Definition Interchange Format
PDISP	Proposed Draft International Standardized Profile
PDL	Page Description Language

PDN	Public Data Network
PDTR	Proposed Draft Technical Report
PDU	Protocol Data Unit
PER	Packed Encoding Rules (ASN.1)
PHIGS	Programmer's Hierarchical Interactive Graphics System
PHY	Physical
PICS	Protocol Implementation Conformance Statement
PLP	Packet Level Protocol (X.25)
PLPS	Presentation Level Protocol Syntax
PM	Processable Mode (of Operations in DTAM)
PMD	Physical Layer Medium Dependent
POC	Profile for Open System Environment Components (EWOS)
POE	Profiles for Open System Environment (EWOS)
POSI	Promoting Conference for OSI (Asia-Oceania Regional Workshop)
POSIX	Portable Operating System Interface for Computer Environments
PPSC-IT	Public Procurement Subcommittee in the Information Technology Sector (CEC)
PPTM	Protocol Profile Conformance Testing Methodology
prENV	Draft European Prestandard
PRMD	Private Management Domain
PSC	Principal Systems Command; Principal Subordinate Command
PSDN	Packet Switched Digital Network
PSN	Packet Switched Network
PSPDN	Packet Switched Public Data Network
PSPvtDN	Packet Switched Private Data Network
PSSG	Protocol Standards Steering Group
PSTN	Public Switched Telephone Network
PSTP	Protocol Standards Technical Panel (see DTMP)
PTI	Public Tool Interface
PTLR	Passive Transport Layer Relay
PTT	Postal, Telegraph, and Telephone
PVC	Permanent Virtual Circuit
PWG	Permanent Working Group
Q&A	Question and Answer (NATO Identification System)
QIP	Quadrilateral Interoperability Programme
QoS	Quality of Service
QSTAG	Quadrilateral Standardization Agreement
QTDMP	Quadrilateral Test and Demonstration Management Plan
QTIDP	Quadrilateral Technical Interface Design Plan
QTIR	Quadrilateral Technical Interface Requirements

R	Relay (profile)
RA	Remote Action
RACWG	Requirement and Design Criteria Working Group (CAIS)
RARE	Reseaux Associes pour le Recherche Europeenne (Association of European Research Networks)
RDA	Remote Data Access (OSI)
RDT	Referenced Data Transfer
RFC	Request for Comment
RFT	Request for Technology
RGB	Red-Green-Blue
RLE	Run Length Encoding
RM	Reference Model
RO	Remote Operations
RODE	Remote Open Document Editing
ROS	Remote Operation Service (OSI)
ROSE	Remote Operation Service Element (OSI)
RPC	Remote Call Procedure
RT	Reliable Transfer
RTS	Reliable Transfer Service (OSI)
RTSE	Reliable Transfer Service Element
RTTS	Real-Time Transport Service
RWS-CC	Regional Workshop Coordinating Committee
SAA	Systems Application Architecture (IBM)
SACF	Single Association Control Function
SANISI	Security Architecture for NATO Information Systems Interconnection
SAO	Single Association Object
SAP	Service Access Point; Subnetwork Access Protocol (Network Layer)
SASO	Saudi Arabian Standards Organization
SATCOM	Satellite Communications
SC	Sub-Committee (ISO); Study Committee
SCARS	Status Control Alerting and Reporting System
SCC	Standards Council of Canada
SCCS	Source Code Control System (AT&T)
SCF	Service Control Facility (ATCCIS)
SCSI	Small Computer System Interface
SD&IC	System Design and Integration Contract (ACE ACCIS)
SDCP	Subnetwork Dependent Convergence Protocoi (OSI Network Layer)
SDIF	SGML Document Interchange Format
SDH	Synchronous Data Hierarchy
SDL	System Development Language (FDT)

SDNS	Secure Data Network System (U.S. National Security Agency)
SDTS	Spatial Data Transfer Specification
SE	Service Element
SECAN	Military Committee Communications Security and Evaluation Agency (NATO)
SEI	Security Exchange Information
SFA	Specified Subfunctional Area
SFS	Suomen Standardisoimisliitto (Finland)
SG	Subgroup
SGFS	Special Group on Functional Standardization (ISO/IEC JTC1)
SGML	Standard Generalized Markup Language
SHAPE	Supreme Headquarters Allied Powers Europe
SICF	Systeme Informatique de Commandement des Forces Terrestres
SICP	Subnetwork Independent Convergence Protocol (OSI Network Layer)
SIGCOMM	Special Interest Group on Data Communications (ACM)
SIG	Special Interest Group (NIST OSI Implementor's Workshop)
SII	System Interconnection Interface (MIA)
SILS	Standard for Interoperable LAN Security
SINCGARS	Single-Channel Ground/Air Radio System (U.S. DoD)
SIS	Standardiseringskommisionen i Sverige (Sweden)
SMF	System Management Facility (ATCCIS)
SMI	Structure of Management Information (OSI)
SMS	Swedish Mechanical Standardization
SMT	Station Management (FDDI)
SMTP	Simple Mail Transfer Protocol (U.S. DoD)
SN	Subnetwork
SNDCP	Subnetwork Dependent Convergence Protocol (OSI Network Layer)
SNICP	Subnetwork Independent Convergence Protocol (OSI Network Layer)
SNPA	Subnetwork Point of Attachment
SOGITS	Senior Official Group for Information Technology Standardization (CEC)
SOGT	Senior Official Group on Telecommunications (CEC)
SP	Security Protocol (SDNS)
SPAG	Standards Promotion and Applications Group
SPARC	Standards and Planning Requirements Committee
SPDL	Standard Page Description Language
SQL	Standard Query Language (ISO)
SRT	Source Routing Transparent (LAN Bridging)
SSI	System Software Interface
SSP	Subnetwork Specific Protocol (Network Layer)

STAMINA	Standard Automated Message Processing Interface for NATO's ACCIS
STANAG	NATO Standardization Agreement
STC	SHAPE Technical Centre
STDL	Structured Transaction Definition Language (MIA)
STL	Standard Text Language
STE	Signalling Terminal
STEP	Standard for the Exchange of Product Model Data
STN	Switched Telephone Network
STRIDA	Systeme de Traitement et de Representation des Informations de Defense Aerienne
SUCOC	Succession of Command
SVID	System V Interface Definition (AT&T Unix)
SWG	Special Working Group (ISO JTC1)
T	Transport (profile)
TADIL	Tactical Digital Information Link
TAOM	Tactical Air Operations Module (U.S. DoD)
TBD	To Be Determined
TC	Transport Connections; Technical Committee (ISO)
TCCA	Time-Critical Communications Architecture
TCCS	Time-Critical Communications System
TCIS	Technical Common Interface Standards (TSGCE SG9)
TCOS	Technical Committee on Operating Systems (IEEE)
TCP	Transmission Control Protocol (U.S. DoD)
TCS	Trusted Communications Sublayer (SANISI)
TCSEC	Trusted Computer System Evaluation Criteria
TEK	Traffic Encryption Key
TF	Transfer Facility (ATCCIS)
TFA	Transparent File Access (POSIX)
TGA	Targa Image Format
TIDP	Technical Interface Design Plan
TIFF	Tag Image File Format
TLV	Tag-Length-Value
TM	Technical Management
TMD	Terminal Management Domain (TM)
TM	Technical Memorandum; Terminal Management
TMN	Telecommunication Management Network
TOP	Technical and Office Protocol
TOR	Terms of Reference
TP	Transaction Processing
TP	Transaction Processing (OSI); Transport Protocol (OSI)

TPDU	Transport Protocol Data Unit (OSI)
TPSUI	Transaction Processing Service User Invocation
TR	Technical Report (ISO)
TRI-TAC	Joint Tactical Communications Program (U.S. DoD)
TS	Transport Service (OSI)
TSA	Time Synchronization Agent
TSG	Technical Study Group (ISO/IEC JTC1)
TSGCE	Tri-Service Group on Communications and Electronics (NATO) (formerly TSGCEE)
TSGCEE	Tri-Service Group on Communications and Electronics Equipment (see TSGCE)
TSS	Time Syncronization Service
TTC	Telecommunications Technology Committee (Japan)
TTCN	Tree and Tabular Combined Notation (ISO)
TUA	Time User Agent
UA	User Agent (MHS)
UDO	User Descriptor Object (TM)
UDT	Unstructured Data Transfer
UER	Union Europeenne de Radiodiffusion
UI	Unix International
UIL	User Interface Language
UIMS	User Interface Management System
UIT	Union Internationale des Telecommunications (CCITT)
ULA	Upper Layer Architecture (OSI)
ULTDS	Unit Level Tactical Data Switch
UN	United Nations
USAREUR	U.S. Army in Europe
USGS	U.S. Geological Survey
UTACCS	USAREUR Tactical Command and Control System
UTC	Coordinated Universal Time
UTE	Union Technique de l'Electricite (France)
VC	Virtual Circuit
VDM-SL	Vienna Development Method-Specification Language
VDT	Visual Display Terminal
VFUIF	Voice/Fax User Interface Forum
VMF	Variable Message Format
VMUIF	Voice Messaging User Interface Forum
VPS	Vector Product Standard

VT	Virtual Terminal (OSI Layer 7)
VTE	Virtual Terminal Environment
VTP	Virtual Terminal Protocol
WAM	WWMCCS Automated Data Processing (ADP) Modernization
WAN	Wide Area Network
WD	Working Draft
WDAD	Working Draft Addendum (ISO)
WDAM	Working Draft Amendment (ISO)
WDISP	Working Draft International Standardized Profile
WG	Working Group
WIN	WWMCCS Intercomputer Network
WIS	WWMCCS Information System
WP	Working Paper (ATCCIS)
WSF	Workstation Function
WWMCCS	World Wide Military Command and Control System
XALS	Extended ALS (OSI)
XID	Exchange Identification
X11	X-Windows, Version 11
XPG3	Third Edition of the X/Open Portability Guide
XSI	X/Open System Interfaces
XTP	Xpress Transfer Protocol
XVS	X/OPEN System V Specification

INDEX

THE USE OF INTEROPERABILITY PARAMETERS TO ENSURE STANDARDS COVERAGE[1]

1. INTEROPERABILITY PARAMETER METHODOLOGY

1.1 General

This section describes a methodology for ensuring adequate standards coverage through detailed analysis of the parameters that are required to achieve interoperability against specific standards that control these parameters.

1.2 Description of the Methodology

An Interoperability Parameter (IP) is a system or design parameter whose control is required to achieve interoperability. These parameters are identified in system specifications, interface control documents, and other requirements documents prior to or very early in the system development process. In many cases, the interoperability parameters are controlled through the specification of a range of standards. The assembled parameters act as a checklist for interoperability, since each IP must be controlled by a suitable standard. The purpose of an analysis using IPs is to recognize and examine all relevant quantities and characteristics in a direct manner, instead of assuming that existing or draft standards will provide adequate coverage of the quantities.

One of the underlying principles for the ATCCIS concept is that specifying standards is essential to ensuring interoperability. However, it cannot be emphasized too strongly that specifying standards alone will not guarantee interoperability. Indeed, every standard has a number of design parameters or IPs whose values may need to be fixed in the design phase of implementation. To ensure interoperability, each of these IPs must also be specified and controlled. Some IPs are very general and may be used to specify a class of options or mode of operation. Other IPs may be very detailed, such as restrictions on timing, format size, or bandwidth.

IPs can be identified and appropriately controlled in any stage of system development, from initial concepts and requirements to detailed design and as-built specifications. Parameters may simply be the identity of governing specifications (e.g., standards) for interface or other requirements. They could be the identity of options or specification of limits on performance requirements. They could include lists of services or routines that are mandated or that are denied for use. IPs may include logical or physical layouts that show such elements as sequences, relationships, interconnections, and logical block diagrams. IPs may include waveforms. They may include operating procedures, such as dial settings. In short, IPs include any information item that needs to be controlled at any stage of development to ensure interoperability.

Because each standard is a reflection of the degree to which agreement can be reached in a service area, many important attributes (i.e., IPs) are often left unspecified or unaddressed. As agreements are reached over time, the standards will improve by addressing more functionality and harmonizing conflicting approaches. In cases where standards identify extensions and other types of options, great care must be taken in standards specification and IP control to ensure that, whenever an extension or option is permitted, every implementation of the related service also supports this extension or option. This principle is especially important in achieving not only interoperability but also portability of applications from one implementation or environment to another, such as is needed when operating systems, data management systems, interface packages, and hardware are upgraded.

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[1] Effective date of this Appendix is July 1990.

1.3 Examples of Interoperability Parameters

This section provides a brief introduction to interoperability parameters by examining portions of three sets of standards:

- Physical standards for 25-pin connectors (i.e., EIA RS-232D interface)
- Electrical characteristics of digital interface circuits (i.e., EIA RS-423A and QSTAG 594)
- Transmission characteristics for single channel radio (i.e., STANAG 4202).

1.3.1 Physical Standards for 25-pin Connectors

Table A-1 identifies a number of electrical and mechanical interoperability parameters controlled by EIA RS-232D for 25-pin connectors. The first two columns provide the definition of the interoperability parameter; the values specified in the standard, if any, are given in the third column.

Table A-1. Example Interoperability Parameters Based on Characteristics of Unbalanced Load Digital Interface Circuits, 25-Pin Interface Connectors

Description of Interoperability Parameter		Example Value of IP
EXAMPLE ELECTRICAL CHARACTERISTICS:		
Undefined condition	Minimum voltage Maximum voltage	-3 volts +3 volts
Marking condition (binary ONE)	Interface Voltage Maximum	-3 volts
Spacing condition (binary ZERO)	Interface Voltage Minimum	+3 volts
Restriction on use of hysteresis techniques to enhance noise immunity		None
Load impedance of the receiver side	Minimum for applied voltage ≤ 25 volts Maximum for applied voltage of 3 to 25 volts	3,000 ohms 7,000 ohms
Effective shunt capacitance of receiver	Maximum	2,500 picofarads
EXAMPLE MECHANICAL CHARACTERISTICS:		
Number of Pins		25
Cable length	Maximum	Not specified
Connector length (male contacts, female shell)	Minimum Maximum	38.84 mm 39.09 mm
Connector width (male contacts, female shell)	Minimum Maximum	8.23 mm 8.48 mm
Contact spacing, Pin #1	Longitudinal offset Lateral offset	+16.56 mm +1.42 mm
Contact spacing, Pin #2	Longitudinal offset Lateral offset	+15.19 mm -1.42 mm
Contact spacing, Pin #25	Longitudinal offset Lateral offset	-16.56 mm +1.42 mm

Table A-1. Continued

Description of Interoperability Parameter		Example Value of IP
Pin diameter	Minimum Maximum	0.98 mm 1.06 mm
Pin length, overall with mounting	Minimum Maximum	9.77 mm 10.03 mm
Pin mounting length	Minimum Maximum	1.57 mm 1.76 mm
Female contact length, overall with mounting	Minimum Maximum	9.27 mm 9.63 mm
Female contact socket depth	Minimum Maximum	7.37 mm 7.37 mm
Pin assignment	Pin #1 Pin #2 Pin #5 Pin #25	Shield Transmitted Data (BA) Clear to Send (CA) Test Mode (TM)
Female contact socket depth	Minimum Maximum	7.37 mm 7.37 mm

Sources:

(1) DIS 2110, *25-Pin DTE/DCE Interface Connector and Pin Assignments* (related to EIA RS-232C), November 1985.

(2) EIA RS-232D, *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, 1986.

(3) EIA RS-449, *General Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, November 1977.

(4) EIA Industrial Electronics Bulletin IEB-12, *Application Notes on Interconnection Between Interface Circuits Using RS-449 and RS-232C*, November 1977.

1.3.2 Electrical' Characteristics of Digital Interface Circuits

Table A-2 identifies interoperability parameters of digital interface circuits that are controlled by QSTAG 594. These are all electrical characteristics.

Table A-2. Example Interoperability Parameters Based on Electrical Characteristics of Unbalanced Load Digital Interface Circuits

Description of Interoperability Parameter		Example Value of IP
Open circuit voltage, generator	Minimum magnitude Maximum magnitude	4 volts 6 volts
Test termination voltage, generator	450 ohm ±1% test load min	90% magnitude of open circuit voltage
Short circuit current, generator	Maximum magnitude	150 mA
Output leakage current, current, generator	Maximum magnitude with applied voltage from -6 V to +6 V	100 µA
Output signal waveform voltage	Minimum magnitude Maximum magnitude Variance between transitions	3.6 volts 6 volts Within 10% steady state
Output signal waveshaping	Rise time to 90% steady state at maximum signaling rate Minimum Maximum Rise time to 90% steady state at signaling rates below 1 kb/s Minimum Maximum	 0.1 unit interval 0.3 unit interval 100 µsec 300 µsec
High impedance state	Requirement Output voltage at high imped and 450 ohm ±1% test load	Optional Zero (nominal)
Wire or cable	Characteristics	Not addressed
Signaling rates		Not specified
Total load	Resistance minimum Required differential input voltage to achieve intended binary state	400 ohms 200 mV
Fail safe	Requirement	Optional

Sources:

(1) QSTAG 594, *Electrical Characteristics of Digital Interface Circuits*, 25 March 1981 (adopts MIL-STD-188-114).

(2) MIL-STD-188-114A, *Electrical Characteristics of Digital Interface Circuits*, 30 September 1985 (Revision of MIL-STD-188-114 dated 24 March 1976).

(3) CCITT V.10/X.26, *Electrical Characteristics for Unbalanced Double-Current Interchange Circuits for General Use With Integrated Circuit Equipment in the Field of Data Communications*, 1985 (related to EIA RS-423A, which is compatible with MIL-STD-188-114A).

(4) EIA RS-423A, *Electrical Characteristics of Unbalanced Voltage Digital Interface Circuits*, December 1978.

1.3.3 Transmission Characteristics for Single Channel Radio

Table A-3 presents a nearly complete summary of the interoperability parameters controlled by STANAG 4202 for single channel radios. This standard is in use in NATO as the basis of interoperability for digital data transmission on combat net radio.

Table A-3. Example Interoperability Parameters Based on Single Channel Radio Standards (STANAG 4202)

Description of Interoperability Parameter		Example Value of IP
Frequency band	Minimum frequency Maximum frequency Channel spacing	Not specified Not specified Not specified
Transmission rates (1)	Preferred rate Other required rates	600 b/s 300, 1,200 (and 150 for HF)
Modulation	Type	FSK
Data	Character coding type	NATO 7-bit
FSK modulation	Mark (or 1) frequency Space (or 0) frequency Audio tone frequency accuracy, transmit Receiver accuracy	1575 Hz 2425 Hz ± 5 Hz (± 1 Hz desired) ± 20 Hz
FSK transition between mark & space	Maximum phase discontinuity	5 degrees
FSK timing	Minimum clock accuracy for synchronous data	± 1 part in 10**5
Keytime delay	Required Options Modulation applied	0.53333, 2.026676 sec Multiples of 0.10667 sec (2) Reversals ending in a zero
Bit synchronization preamble	Length Modulation	33 bits Reversals ending in a "1"
Character synchronization preamble	Length Modulation	63 bits Pseudo-random sequence generated by a (6,1) shift register starting with "111111"
Message preparation for transmission	Initial character Message structure Message padding	"SI" or "NUL" (clear, respectively, encrypted text follows) 7-bit bytes Up to 6 "1" bits
Cyclic redundancy check (applied to the entire input message)	CRC type Generator (mod 2) Conversion to 8-bit byte Size of check CRC padding	Polynomial x**16+x**12+x**5+1 0 in most significant bit Three 7-bit bytes NATO 7-bit end-of-text chars as required (up to 15) (3)
Envelope termination	Size	Four 7-bit characters NATO 7-bit end-of-text chars

Notes:

(1) STANAG 4202 (Appendix B) provides guidelines for interim use of 16,000 b/s channels that are not shown in this table.

(2) 0.10667 sec is the time to send 128 bits at 1,200 b/s or 64 bits at 600 b/s.

(3) The minimum message is 16x7 or 112 bits and requires 0.19 sec at 600 b/s.

Table A-3. Continued

Description of Interoperability Parameter		Example Value of IP
Error detection and correction coding (applied to 7-bit bytes)	ED&C type	Hamming (12,7), produces 12-bit coding for every 7-bit byte
Time dispersal coding	TDC interleaving array size	16x12, with sixteen 12-bit Hamming codes
Errors	Number of acceptable but uncorrectable errors	None (stop processing and send no NACK)

Source: STANAG 4202 EL (Edition 2), *Transmission Envelope Characteristics for High Reliability Data Exchange Between Land Tactical Data Processing Equipment Over Single Channel Radio Links*, Military Agency for Standardization, NATO, 25 May 1988.

1.3.3 Interoperability Parameters for X.25 Packet Switching

Table A-4 provides the interoperability parameters for the Implementor's Agreements on the X.25 packet switching protocol as defined in the 1989 NIST Workshop stable agreements that apply to U.S. GOSIP Version 1.0.[2] The NIST Workshop understands that agreement to these interoperability parameters will ensure interoperability of implementations of the X.25 protocols.[3]

2. USING INTEROPERABILITY PARAMETERS TO CHARACTERIZE MILITARY FEATURES IN OSI-RELATED TACTICAL STANDARDS

This section is intended to be expanded to demonstrate the use of interoperability parameters to describe how some fielded tactical data systems are implementing military versions of OSI standards to achieve interoperability. The descriptions here extend the tables provided in Chapter 9 to describe the Quadrilateral Interoperability Program and STAMINA. Examples will also be taken from Appendix C, National Initiatives for Military Use of OSI Standards.

2 *Stable Implementation Agreements for Open Systems Interconnection Protocols*, Version 2, Edition 1, NIST Special Publication 500-16, National Institute of Standards and Technology, December 1988, UNCLASSIFIED.

3 Private communication with Director, Systems and Network Architecture Division, NIST, 25 May 1989.

Table A-4. Interoperability Parameters for X.25 Packet Switching

	ISO Layer & Function	Standards Cited	Notes on Interoperability Parameters
-	General	CCITT X.25	• Defines procedures required to describe the DTE side of a DTE/DCE interface for systems attached to subnetworks providing an X.25 interface shall be as defined in ISO 7776 and ISO 8208 as indicated below. • These procedures shall also apply to a DTE operating on a DTE/DTE interface.
3	Network Layer	ISO 8208 (X.25 PLP)	• The elements of ISO 8208 applicable for use depend on the OSI role of ISO 8208 (i.e., provision of CONS, support of CLNP): a. When ISO 8208 is used to support CONS, the optional user facilities in Section 5.1 of ISO 8878 shall be supported. b. When ISO 8208 is used to support CLNP (when providing the CLNS), Permanent Virtual Circuit may be used. • Virtual Call Service is required. • Any mutually agreed window and packet size may be used; however, all DTEs must be capable of supporting a window size of 2, a packet size of 128 octets, and a sequence number modulus of 8. • The Basic RPOA Selection Facility shall be implemented and its use or non-use selectable on a per virtual call basis. (1)
2	Data Link Layer	ISO 7776 (HDLC Procedures-- X.25 LAPB)	• The address assignments are: DTE = A (=11000000 binary) DCE = B (=10000000 binary). On a DTE/DTE interface, one of the DTEs, by a prior agreement, shall use the DCE address. • The modulus shall be 8. • A window size (k) of 7 shall be supported. In addition, other window sizes may also be supported. • The Multilink Procedures are excluded.

Notes:

1. Agreement on the Basic RPOA Selection Facility parameter is an ongoing, not a stable, implementation agreement.

References:

1. Stable Implementation Agreements for Open Systems Interconnection Protocols, Version 1, Edition 1, NIST, December 1988.
2. Ongoing Implementation Agreements for Open Systems Interconnection Protocols: Continuing Agreements, NISTIR 88-3824-2, NIST, February 1989.

FUNCTIONAL PROFILES IDENTIFIED IN THE NTIS TRANSITION STRATEGY[1]

1. INTRODUCTION

The *NATO Technical Interoperability Standards (NTIS) Transition Strategy* [Purton 1987] is developed by the Tri-Service Group on Communications and Electronics (TSGCE) and promulgated by the Conference of National Armaments Directors (CNAD). This appendix identifies the functional profiles identified in the 1989 *NTIS Transition Strategy*. All are based on existing or emerging recommendations developed by international or regional standards bodies. Most are based on recommendations from the European Workshop for Open Systems (EWOS).

The notation used to identify and distinguish the functional profiles is that currently being used by EWOS. This notation will be changed in future editions of the *NTIS Transition Strategy* to the taxonomy developed by ISO in TR 10000. The ISO taxonomy is described in Section 6.4.2.

2. APPLICATION PROFILES

There are four functional profiles identified in Figure B-1:

- A.111, Simple File Transfer
- A.221, Basic Teletex
- A.331, Message Handling Service for Interpersonal Messaging (IPM): IPM End System to IPM End System
- A.332, Message Handling Service for IPM: User Agent (UA) to Message Store (MS).

7	ISO 8571 ISO 8650
6	ISO 8823 ISO 8824 ISO 8825
5	ISO 8327

(a) A.111, Simple File Transfer

7	CCITT - T.60
6	CCITT - T.61
5	CCITT - T.62

(b) A.221, Basic Teletex

7	IPM service MT service MT protocol Reliable transfer Association control	ISO 10021-7/X.420 ISO 10021-4/X.411 ISO 10021-6/X.419 ISO 9066-2 ISO 8650
6		ISO 8823 ISO 8824 ISO 8825
5		ISO 8327

(c) A.331, Message Handling Service: Interpersonal Messaging: IPM End System to IPM End System

7	MS service IPM service MT service MT protocol Remote Operations Reliable transfer Association control	ISO 10021-5/X.413 ISO 10021-7/X.420 ISO 10021-4/X.411 ISO 10021-6/X.419 ISO 9072-2 ISO 9066-2 ISO 8650
6		ISO 8823 ISO 8824 ISO 8825
5		ISO 8327

(d) A.332, Message Handling Service: Interpersonal Messaging: UA to MS

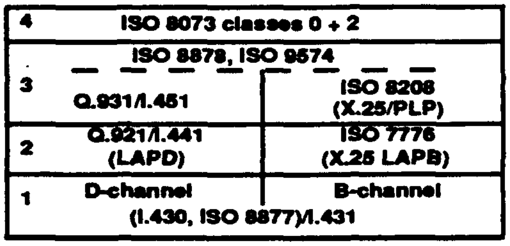
Figure B-1. Application Functional Profiles

[1] Effective date of this Appendix is July 1990.

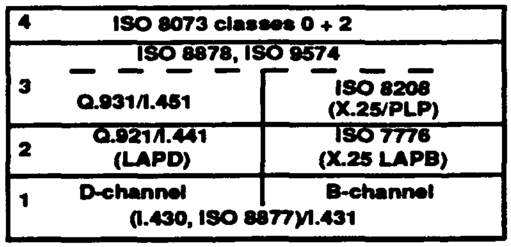
3. TRANSPORT PROFILES

Figure B-2 identifies 20 transport profiles. The first four [B-2(a) to B-2(d)] are for the Integrated Services Digital Network (ISDN):

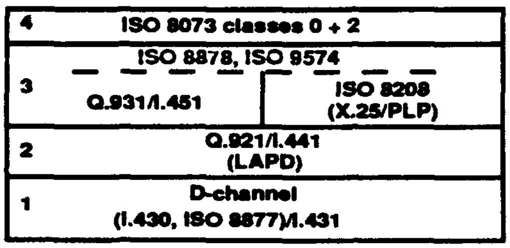
- T.111x,[2] ISDN Circuit Switched Bearer Services over the Connection-Oriented Network Service (CONS) using the B-Channel (LAP B, X.25/PLP)
- T.121x, ISDN Packet Switched Bearer Services over CONS using the B-Channel (X.31)
- T.122, ISDN Packet Switched Bearer Services over CONS using the D-Channel (X.31)
- T.131x, ISDN Port Access to a Packet Switched Digital Network (PSDN) (X.31, X.32).



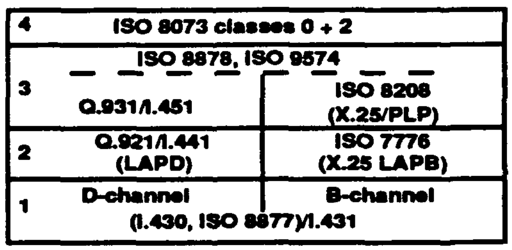
(a) T.111, ISDN Circuit Switched Bearer Services CONS Using B-Channel



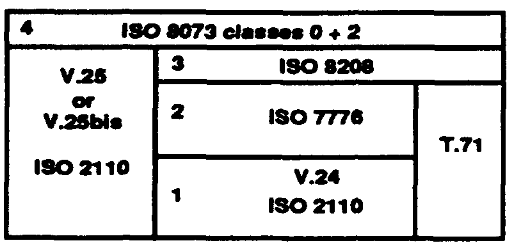
(b) T.121, ISDN Packet Switched Bearer Service CONS Using B-Channel (X.31 Case B)



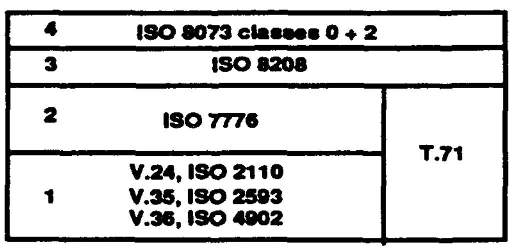
(c) T.122, ISDN Circuit Switched Bearer Services CONS Using D-Channel



(d) T.131, ISDN Port Access to a PSDN (X.31 Case A/X.32)



(e) T.21, Analogue Telephone Circuit, Permanent Circuit (CONS)



(f) T.22, Analogue Telephone Circuit, Switched Circuit (CONS)

Figure B-2. Transport Functional Profiles

2 In the ISDN profiles, x=1 for the Permanent case and x=2 for the Switched case.

4	ISO 8073 classes 0 + 2
3	ISO 8208
2	ISO 7776
1	X.21 X.21bis

(g) T.31x, Permanent Access to a PSDN, T.70/CONS

4	Draft STANAG 4264 classes 0 + 2
3	Draft STANAG 4263
2	Draft STANAG 4262
1	Draft STANAG 4261

(h) T.312M, Permanent Access to a PSDN, CONS (Military)

4	ISO 8073 class 0	
3	ISO 8208	X.32
2	ISO 7776	
1	X.25 level 1	

(i) T.321, Switched Access to a PSDN, CONS, Telephone Circuit Access

4	ISO 8073 classes 0,2	
3	ISO 8208	X.32
2	ISO 7776	
1	X.25 level 1	

(j) T.322, Switched Access to a PSDN, CONS, Digital Data Circuit Access

4	ISO 8073 classes 0 + 2	
X.21	3	T.70
	2	T.70
1	CCITT X.21	

(k) T.41, Digital Data Circuit, Telematic End Systems, T.70 Case

4	ISO 8073 classes 0 + 2	
X.21	3	ISO 8208 ISO 8878
	2	ISO 7776
1	CCITT X.21	

(l) T.42X, Digital Data Circuit, CONS

Figure B-2. Continued

4	ISO 8073 classes 0 + 2	
3	ISO 8208 ISO 8878	ISO 8881
2	ISO 8802-2 class II	
1	ISO 8802-3	

(m) T.611, Local Area Network
CSMA/CD, CONS

4	ISO 8073 classes 0 + 2	
3	ISO 8208 ISO 8878	ISO 8881
2	ISO 8802-2 class II	
1	ISO 8802-4	

(n) T.612, Local Area network
Token Bus, CONS

4	ISO 8073 classes 0 + 2	
3	ISO 8208 ISO 8878	ISO 8881
2	ISO 8802-2 class II	
1	ISO 8802-5	

(o) T.613, Local Area Network
Token Ring, CONS

4	ISO 8073 class 4
3	ISO 8473 inactive subset
2	ISO 8802-2 (type 1)
1	ISO 8802-3

(p) T.6211, Local Area Network
CSMA/CD, CLNS Single-LAN
Environment

4	ISO 8073 class 4
3	ISO 8473
2	ISO 8802-2 (type 1)
1	ISO 8802-3

(q) T.6212, Local Area Network
CSMA/CD, CLNS Multiple-LAN
Environment

4	ISO 8073 class 4
3	ISO 8473
2	ISO 8802-2 (type 1)
1	ISO 8802-4

(r) T.622, Local Area Network
Token Bus, CLNS Multiple-LAN
Environment

4	ISO 8073 class 4
3	ISO 8473 inactive subset
2	ISO 8802-2 (type 1)
1	ISO 8802-5

(s) T.6231, Local Area Network
Token Ring, CLNS Single-LAN
Environment

4	ISO 8073 class 4
3	ISO 8473
2	ISO 8802-2 (type 1)
1	ISO 8802-5

(t) T.6232, Local Area Network
Token Ring, CLNS Multiple-LAN
Environment

Figure B-2. Continued

Two of the transport profiles [B-2(e) and B-2(f)] are for analog telephone circuits:

- T.21, Permanent Circuit with CONS
- T.22, Switched Circuit with CONS.

Four PSDN transport profiles [B-2(g) through B-2(j)] are shown in Figure B-2:[3]

- T.31x, Permanent Access to a PSDN, Using T.70 (T.311) or CONS (T.312)
- T.312M, Permanent Access to a PSDN with CONS (draft STANAG for military use)
- T.321, Switched Access to a PSDN, Telephone Circuit, Using Transport Protocol Class 0 (TP0) over CONS
- T.322, Switched Access to a PSDN, Data Circuit, Using TP0 and TP2 over CONS.

Two digital data circuit transport profiles [B-2(k) and B-2(l)] are shown in Figure B-2:

- T.41, Digital Data Circuit for Telematic End Systems Using T.70
- T.42x, Digital Data Circuit Using CONS (T.421 for Permanent Circuit and T.422 for Switched Circuit).

The final six transport profiles [B-2(m) and B-2(t] are for local area networks (LANs):[4]

- T.611, CSMA/CD LAN with CONS
- T.612, Token Bus LAN with CONS
- T.613, Token Ring LAN with CONS
- T.6211, CSMA/CD LAN, CLNS Single-LAN Environment
- T.6212, CSMA/CD LAN, CLNS Multiple-LAN Environment
- T.622, Token Bus, CLNS Multiple-LAN Environment
- T.6231, Token Ring LAN, CLNS Single-LAN Environment
- T.6232, Token Ring LAN, CLNS Multiple-LAN Environment.

4. RELAY PROFILES

Figure B-3 identifies 11 relay profiles. These are:

- Relaying the CONS:[5]
  - R.11, LAN to LAN
  - R.12, LAN to X.25 (PSDN)
- Relaying the CLNS:
  - R.21, LAN to LAN
  - R.22, LAN to X.25 (PSDN)
- Relaying the X.25 Packet Layer Protocol:
  - R.31, LAN to LAN
  - R.32, LAN to X.25 (PSDN, Virtual Call)
  - R.33, X.25 (PSDN, Virtual Call) to X.25 (PSDN, Virtual Call)

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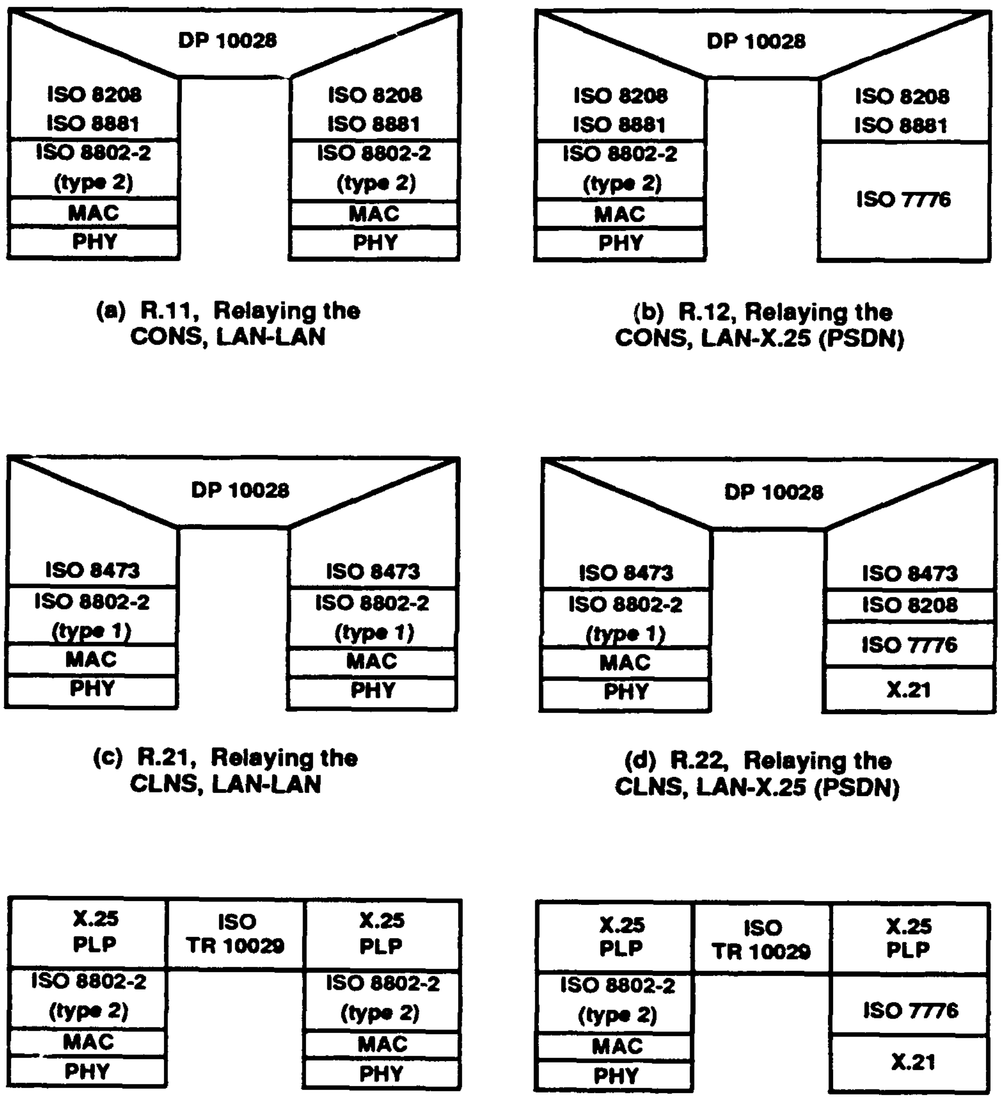
3 All the T-profiles provide the Connection-Oriented Transport Service (COTS). U-profiles would use the Connectionless Transport Services (CLTS)--no U-profiles have been identified in the 1989 *NTIS Transition Strategy*.

4 No T-profiles are given in the 1989 *NTIS Transition Strategy* for T.614, Fiber Distributed Data Interface (FDDI) LAN with CONS or for T.624, FDDI LAN with CLNS.

5 The 1989 *NTIS Transition Strategy* also identifies (without specifying the protocol stacks) a military profile being developed in SG9 WG1 for R.131(M), Relaying the CONS, WAN/PSDN to WAN/PSDN Using X.75.

- Relaying the Media Access Control (MAC) Service:
  - R.41, CSMA/CD to CSMA/CD
  - R.42, CSMA/CD to Token Ring
  - R.43, Token Ring to Token Ring
  - R.44, CSMA/CD to Fiber Distributed Data Interface (FDDI).



(a) R.11, Relaying the CONS, LAN-LAN

(b) R.12, Relaying the CONS, LAN-X.25 (PSDN)

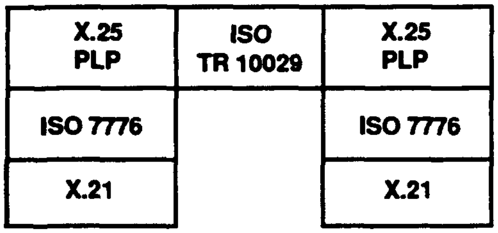
(c) R.21, Relaying the CLNS, LAN-LAN

(d) R.22, Relaying the CLNS, LAN-X.25 (PSDN)

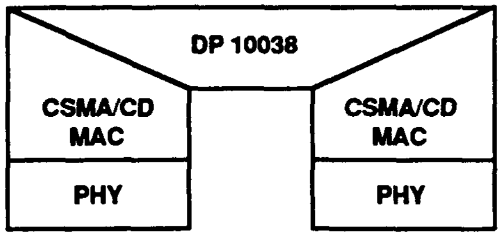
(e) R.31, Relaying the X.25 Packet Layer Protocol, LAN-LAN

(f) R.32, Relaying the X.25 Packet Layer Protocol, LAN-X.25 (PSDN, Virtual Call)

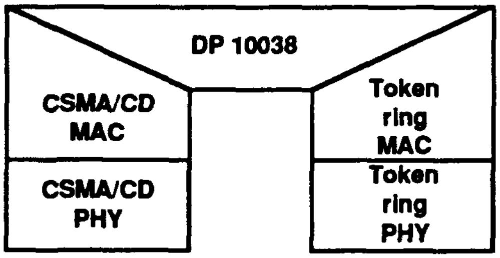
Figure B-3. Relay Functional Profiles



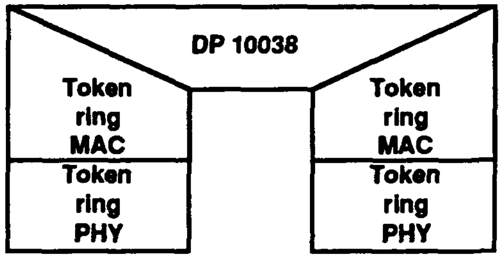
(g) R.33, Relaying the X.25 PLP, X.25 (PSDN Virtual Call)-(PSDN, Virtual Call)



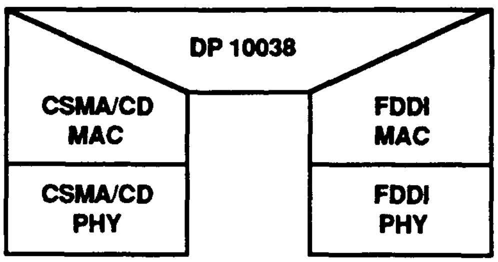
(h) R.41, Relaying the MAC Service, CSMA/CD-CSMA/CD



(i) R.42, Relaying the MAC Service, CSMA/CD-Token Ring



(j) R.43, Relaying the MAC Service, Token Ring-Token Ring



(k) R.44, Relaying the MAC Service, CSMA/CD-FDDI

Figure B-3. Continued

NATIONAL INITIATIVES FOR MILITARY USE OF OSI STANDARDS[1]

1. INTRODUCTION

1.1 General

This appendix identifies national initiatives that make or plan to make significant use of OSI standards in military applications. Major bilateral and multilateral initiatives are discussed in the main body of this working paper; these include the Quadrilateral Interoperability Program (Appendix K) and STAMINA (Appendix K).

1.2 Purpose

The primary purpose of this review of national initiatives is to identify the ways in which military features are being addressed in national systems. In some cases, there may be fully compliant use of OSI standards. In other cases, there may be defined some extensions to the standards that could be considered by international bodies as candidates for new options to the commercial standards, so that in the time frame of ATCCIS (and other NATO CCIS projects) the military features (e.g., a secure local area network) may be specified by civil standards. On the other hand, analysis of national initiatives may lead to conclusions that some features may need to be specified as deviations from civil standards and, in these cases, the relevant STANAGs may need to have similar deviations.

1.3 Scope and Organization

National initiatives discussed in Section 2 are addressed, where possible, in terms of requirements, profiles, and transition strategies that have been recommended or adopted. A short review is provided in Section 3 of work being done to evaluate the performance of civil standards for military applications. Several initiatives that have led to fielded operational capabilities are discussed in Section 4 in some detail.

2. OVERVIEW OF NATIONAL INITIATIVES TO IMPLEMENT OSI STANDARDS IN MILITARY AND RELATED SYSTEMS

2.1 France

Army Tactical CCIS Systems. Army tactical CCIS systems in France are using or are projecting to use more and more components based on OSI standards. The Army is following the general recommendations of standards organizations such as AFNOR, SPAG, CCITT, and CEN/CENELEC (see Appendix F), and would thereby try to use, wherever possible, the products (hardware and software) built upon these standards.

One example of the implementation of OSI standards in Army tactical systems is the use of ETHERNET™ (ISO 8802.3) to link cells within a command post. In addition, tactical networks, such as RITTER and RETINAT, are based on CCITT X.25 packet switched standards. Table C-1 identifies the international OSI standards that the Army intends to use in its standardized MHS Gateway, based on QTIDP specification.

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1 Effective date of this Appendix is July 1990.

Table C-1. French Army Standardized MHS Gateway

OSI Layer	International Standard	Brief Title of Standard
Application (Layer 7)	CCITT X.400 ISO 9066-2 ISO 8649, 8650	MHS RTSE ACSE
Presentation (Layer 6)	CCITT X.409	Abstract Syntax Notation
Session (Layer 5)	ISO 8326, 8327	Basic Service and Protocol
Transport (Layer 4)	ISO 8072, 8073	Class 2 Service and Protocol
Network (Layer 3)	ISO 8208	Basic Service and Protocol
Data Link (Layer 2)	ISO 7776	HDLC LAP B
Physical (Layer 1)	CCITT X.21	

RETINAT. RETINAT is a data communications systems for the French Army. The network operates 33 switches of two types (one for military districts and one for military regions). The network accommodates 1,400 synchronous and 600 asynchronous ports and supports data rates from 300 bps to 64 Kbps. The switches are interconnected with 64-Kbps trunks and use X.75 gateways for interoperability with other data networks.[2]

Real Time Transport Service (RTTS). The French MOD has developed an architecture and implementations of that architecture for a Real Time Transport Service (RTTS). GAM-T-103 is a specification for an implementation of this architecture.[3] RTTS results from more than 15 years of experience in the design and realization of real-time data networks for military systems. RTTS provides not only data communication services but also synchronization and management services. RTTS was described at the June 1990 Military OSI Symposium at STC.[4] The paper addressed the ISO Transport Service, real-time constraints, and a proposed real-time Transport Service. It presented the classes of service, the models used for data transfer, the connection-oriented and connectionless modes for communication services, the synchronization services, and the management services. RTTS has been proposed in draft STANAG 4254 (Annex E) as the basis for defining real-time services for NATO CCISs.

Public Message System. ATLAS 400 is a public messaging system based on CCITT MHS X.400-1984 and is a good illustration of the national implementation of X.400 standards. Administration and design of ATLAS 400 is under the responsibility of TRANSPAC, a public company that is a

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2 *Secure Data Communication Defence System*, Vincenzo Cassese, ALCATEL CIT, France, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

3 *Military Real Time Local Area Network*, GAM-T-103, Ministre de la Defense, Republique Francaise, 9 February 1987, UNCLASSIFIED.

4 *Definition of Real-Time Services for the OSI Transport Layer*, Pascal Prophete, STEI, French MOD, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

subsidiary of FRANCE TELECOM. The ATLAS 400 services can be provided to private companies or administrations, and different kinds of systems can be built:

- A large company can get its own "private" messaging system, and all the nodes can be split throughout the country at the company's different locations.
- It is also possible to get a system that allows different organizations (public or private) to exchange messages between them. This can be useful, for example, to exchange documents between provider and client. Such an implementation would be used to exchange information between different companies.

The ATLAS 400 functional profile is defined in *Specification Technique d'Utilisation et de Raccordement (STUR) ATLAS 400*, which defines Layers 1 to 7. This document also derives from an early effort of the Centre National d'Etude des Telecommunications (CNET) to promote the X-Series standardization (this work, named ARCHITEL, is described below).

ATLAS 400 is only an interpersonal messaging system, and so uses only the Interpersonal Messaging Protocol from the X.400 Series. ATLAS 400 can also be adapted to the size of the company's computer equipment. For example, the Message Transfer Agent may be locally implemented or derived from the ATLAS 400 implementation. Thus, the User Agent and the Message Transfer Agent are not necessarily co-resident. This illustrates the possibilities of tailoring the system to client use.

ARCHITEL. Historically, ARCHITEL is a group effort within CNET. Its purpose was to promote the use of X-Series standards for the widespread use of FRANCE TELECOM and telecommunications companies, in particular by the CNET contractors. ARCHITEL defined X-Series profiles in the early 1980s. ARCHITEL implemented these profiles, specifically those for the lower five layers, to validate the parameters and options used for interoperation and also to clarify the standards where necessary. In some cases, ARCHITEL identified and developed recommendations to address portions of the standards that were judged to be imprecise. The profiles defined in ARCHITEL specified Class 0 and Class 2 for the Transport Layer and the connection-oriented network service for CCITT X.25. (X.25 is used in the public packet switched network, TRANSPAC.)

The ARCHITEL profile is a complete specification that precludes at Layer 3 such capabilities as adding user data to a packet call, using nonstandard packet sizes, etc. All the parameters and options for each layer needed to ensure interoperation are addressed.

ARCHITEL has published the reference document, *STUR ARCHITEL*, which states all the functional profiles for the lower five layers of the CCITT OSI Reference Model (e.g., X.215 and X.225 for the Session Layer). STUR ARCHITEL is informative, not mandatory. It was one of the earliest functional profile descriptions for the industrial community and was therefore instrumental in providing proof of concept of the use of OSI standards on a national scale. Thus, historically, STUR ARCHITEL was the basis for the development for OSI implementations now in use by the military. The military implementations have also included Transport Class 3.

2.2 Netherlands, Norway, France, United Kingdom

Four NATO nations are participating in a project entitled "Cooperative Prefeasibility Studies for Tactical Communications Systems for the Land Combat Zone--Post 2000." In this study, candidate subsystem architectures are being developed on the basis of current and near future communications technologies as ISDN, EUROCOM, FDDI, PABX, packet radio and cellular telephony. From these technologies six subsystem architecture alternatives were derived each with either a nodal (centralized) or a nodeless (distributed) characteristic.

From this set, subsystem architectures are selected on the basis of military operational requirements and threat expectations to form one system architecture for the entire Land Combat Zone. The chosen system architecture to cover the intermediate and the rear zone of the land combat zone. The wide

area communications subsystem consists of a backbone of distributed Local Area Communications Subsystem (LACS) elements with centralized LACS elements providing access to the backbone.[5]

2.3 United Kingdom

Robust Protocols Research Programme. The U.K. MOD and NATO has established the Robust Protocols Research Programme at RSRE to quantify and minimize the risks associated with the U.K. MOD and NATO policies for procuring future CCISs to ISO OSI standards. The approach being taken is to take commercial off-the-shelf protocols that are as near as possible to the perceived military requirement. The performance of these protocols is being established under ideal and degraded conditions in the laboratory.

Initial work has concentrated on the X.400 and FTAM standards. A protocol stack, using X.400 or FTAM, Transport Service Class 4 (TP4), and connectionless network service (CLNS) over X.25(1984) has been selected. These were selected to give a worst case scenario for evaluating the protocol standards. Early results have provided an upper bound to the overheads that may be experienced under ideal conditions. This result will be used for the design and sizing of messaging networks. Some measurements on the performance of FTAM over degraded links have also been obtained. These have shown how a more "intelligent" implementation of the data link protocol could provide optimum throughput over a range of degraded conditions.[6]

Defence Fixed Telecommunications System (DFTS). MOD central Defense staffs are establishing a Defence Packet Switched Network (DPSN). This project is a major element of a wider Defense-wide communications infrastructure covering all communications services: the DFTS. Over time, the present MOD and Armed Forces communications systems will integrate to DFTS. Profiles that have been recommended for the DFTS are of three types: end-system services, common application services, and basic communications services. End-system services, together with the proposed standards, are electronic trading (based on EDI), revisable document exchange (based on ODA), general file transfer (based on FTAM), remote terminal access (based on VT), inter-personal messaging (based on MMHS), and inter-organizational messaging (also based on MMHS). Common application services include message handling (MMHS), Directory, ACP 127 interworking (MMHS), shared file store (FTAM), and shared database (RDA and SQL). The basic communications service profiles are T.31(M) for WAN access, T/611 and T/613 for LAN access, R.131(M) for WAN-to-WAN relay, and R/21 for LAN-to-LAN relay.[7]

The U.K. MOD has a commitment to provide its Single Service strategic communications needs via a common communication network (DFTS). It is also MOD policy that such provision should, to the greatest extent possible, be procured from the civil market to standards recognized by the international community. Progress in implementing the DFTS has been slow as the priority of each of the Single Services has been to deploy their own systems, leaving convergence to DFTS until a later date. However, one subset of DFTS, the packet switched data communications network (DPSN), was identified as requiring common provision to satisfy immediate operational needs.

The DPSN procurement has been guided by the DFTS Architecture and Procurement Working Group (DAPWG), which recommended that (1) the network be based upon the internationally recognized X.25 standard for network access; and (2) potential candidate network systems should be mature, have

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5 *Post 2000 Communications Architectures*, A. T. A. M. van de Voort, TNO Physics and Electronics Laboratory, Netherlands, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

6 *Practical Evaluation of OSI Protocols*, J. Price, D.B. Hearn, J. Laws, A.F. Martin, and J. Staromlynska, RSRE, U.K. MOD, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

7 *MOD(U.K.) Plans for OSI: Civil Section Relationship*, M. A. Bailey, MOD(U.K.) Directorate General of Information Technology Systems (DGITS), Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

considerable expansion capability, and be supported by a manufacturer with a total commitment to the product and development of the relevant standards. The procurement has been distinguished by the short time scale between statement of requirement and in-service operation, and being both within the financial provision and satisfying the operational requirement. For the future some significant issues have to be developed and resolved, not the least being interworking with other systems, e.g., ISDN, multilevel security and management across the boundary between DPSN and end-user systems.[8]

3. IDENTIFICATION OF EFFORTS TO EVALUATE THE PERFORMANCE OF CIVIL STANDARDS FOR MILITARY USE

3.1 Introduction

This section identifies a number of papers submitted in June 1990 to the Military OSI Symposium at SHAPE Technical Centre that describes analytical and demonstration efforts to evaluate the performance of OSI and other protocols for use in military systems. These papers should be consulted for detailed results.

3.2 Sources of Reports on Performance Evaluations

Practical Evaluation of OSI Protocols. This paper summarizes work being done under the Robust Protocols Research Programme at the Royal Signals and Radar Establishment (RSRE) in the U.K. MOD. As noted in Section 2.3, the work has concentrated on X.400 and FTAM over TP4, CLNS, and X.25.[9]

User Performance of Tactical Networks in the ITDN. User performance experiments were conducted in 1989 on portions of the Integrated Tactical-Strategic Data Network (ITDN) Demonstration that simulated tactical areas at echelons corps and below. The performance of four tactical links [Fleet Satellite Communications (FLTSATCOM), MSE line-of-sight radio, Tactical Satellite Communications (TACSATCOM), and Very Small Aperture Terminal (VSAT)] was measured at the protocol level that most directly affects the network user. The results, though preliminary, can help predict the performance of applications in tactical nets. U.S. DoD protocols were measured; however, the results may provide the basis for informed conjectures about the user-level performance of OSI protocols.[10]

Transport Protocols and Internetworking in Low Bandwidth Tactical Networks. This paper examines the impact of packet size on end-to-end functionality (including reliable delivery, packet resequencing, segmentation, and flow control). Tradeoffs between a small packet size required because of the unreliable media and a large packet size required to minimize the header overhead are considered using standard transport protocols. The choice of ULP depends on the application required to run over the network; for instance, military messaging application could use X.400 and its supporting presentation and session layers as specified in U.S. GOSIP or the enhanced versions proposed in STANAGs 4265-4269.

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8 *U.K. Defence Packet Switched Network (DPSN),* Alan Dibble, DSLC, and John Laws, RSRE, U.K. MOD, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED

9 *Practical Evaluation of OSI Protocols,* J. Price, D.B. Hearn, J. Laws, A.F. Martin, and J. Staromlynska, RSRE, U.K. MOD, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

10 *User Performance of Tactical Networks in the ITDN,* Gladys Reichlen and Allison Mankin, The Mitre Corporation, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

The paper also assess the impact of the transport protocol selection on the network architecture in an internetwork configuration.[11]

4. DETAILED REVIEW OF SELECTED NATIONAL INITIATIVES

4.1 Example of a Broadcast Profile for Data Communications Using Tactical Radios

This section uses the OSI Reference Model and interoperability parameters to identify interpretations, extensions, and deviations to OSI and other standards in the specification of a set of protocols used to support data transmission over combat net radio by the U.S Marine Corps. These protocols are specified in Volume V of the Marine Corps MTS TIDP.

The MTS protocols were developed based on U.S. federal standards in the late 1970s. Many of the standards selected have become ISO standards, and the structure of the MTS protocols can be interpreted in terms of the seven-layer OSI Reference Model. The MTS broadcast profile, discussed in this section, is now being used by the Army and the Marine Corps as the basis for defining the initial protocol standards to be used in the TIDP now being developed for Joint Interoperability of Tactical Command and Control Systems (JINTACCS) K-Series Variable Message Format (VMF) bit-oriented messages. The K-Series messages and associated data communications protocols are being specified by the joint Fire Support Subgroup (FSSG) of the Joint Multi-TADIL Standards Working Group (JMSWG) under the auspices of the Joint Tactical C3 Agency.

Table C-2 highlights the features provided in the broadcast protocol, used in Marine Corps tactical data systems (TDSs), for each of the seven layers. It further identifies the standards used in each layer and notes the interpretations, exceptions, extensions, and deviations that were specified.

Military features supported by the broadcast protocol standard and identified in Table C-2 include:

- Multiaddressing (Layer 7, through the Message Header; and Layer 2, through the extended address field)
- Data integrity and, more generally, the capability to operate in a high bit-error-rate environment [Layer 2, through use of a 32-bit frame check sequence (FCS) for error checking and the (23,12) half-rate Golay error detection and correction coding (ED&C), together with 16x24-bit interleaving]
- Use of XID command and response (Layer 2)
- Control of emanations by senders and recipients through provisions for optional acknowledgements (ACKs) (Layer 7--request for ACK is part of the message) and for not sending ACKs even when requested (Layer 2), both under operator control
- Limit on the number of retransmissions permitted (Layer 2)
- Providing for net access (uses an international standard in Layer 2 for handling media access contention and collision detection[12] and defines an algorithm for wait times for reattempting access); net access algorithms could be extended to support precedence and preemption.

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[11] *Transport Protocols and Internetworking in Low Bandwidth Tactical Networks*, Shiraz G. Bhanji, The Mitre Corporation, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

[12] The listen-before-talk contention method is called Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

4.2 Example of a "Datagram" Switched Protocol Standard for Tactical Radios

This section summarizes a set of protocols used to support data transmission through tactical data switches by the U.S. Marine Corps. These are the MTS switched protocols that are specified in Volume V of the Marine Corps *Technical Interface Design Plan for Marine Tactical Systems.*

Table C-3 highlights the features provided in the switched MTS protocol for each of the seven layers. The table identifies the international and U.S. standards used in each layer, and notes the interpretations, exceptions, extensions, and deviations that are specified.

4.3 Details of Standards for French National Initiatives for Enhanced Interoperability

The Army will use standardized products based on the following standards:

- Programming language: LTR3 (Language Temps Reel), Ada, C
- Database: Relational database management systems, SQL
- Operating System: UNIX
- Development methods: Based on the French military standard GAM-T-17.

Table C-2. A Functional Profile of Broadcast Protocols Used in Tactical Systems by the U.S. Marine Corps

ISO Layer, Function		Standards Cited	Notes on Interoperability Parameters
7	Msg Header Msg Acknowledgment	None None	Supports multiple addresses, precedence, and security classification.
6	Msg Format	None	Uses the same flagging scheme as the syntax adopted for U.S. JINTACCS K-series messages.
	Information Field Size	None	Maximum message length is 3500 octets.
5	None	N/A	Null layer.
4	None	N/A	Null layer.
3	Message Segmenting	N/A	Messages are not segmented.
2	Frame Formatting	ISO 3309/7809 (HDLC) with Options 7 and 14	Opt 7=Extended Address Field; 2-17 octets (base std is one octet; Opt 7 specifies no maximum on extended address field size). Opt 14=32-bit frame check seq (FCS) (base standard is 16-bit FCS).
	Frame Addressing	ISO 3309	
	Commands & Responses	ISO 4335/7809 with Option 1	Opt 1=XID. Does not support SABM, DISC cmds and FRMR,UA,DM resp (radio application). Does not support P/F bit.
	Media Access	No standard applies	Uses CSMA/CD with unique algorithms for reattempting access to net.
	Data Link Initialization and Release	ISO 4335/7809 with Option 1 (XID)	XID is used during net establishment.
	Frame Transfer	ISO 4335/7809	Uses all 3 types of frames.
	Acknowledgment (ACK)	ISO 4335	ACK is optional; when invoked, it follows the standard.
	Retransmission	Not controlled by standards	Max 2 retries (under operator control) (no provision for setting a max in stds). Standards suggest use of P/F bit to control retransmission.
	ED&C--Error Detection	IS 3309/7809 w Opt 14	32-bit FCS (algorithm is ISO 3309, Sec 3.6.3).
	ED&C--Error Coding	Not controlled by standards	(23,12) half-rate Golay; 24th bit is zero filled (detects 6/corrects 3 errors in each 24-bit codeword).
	ED&C--Interleaving	Not controlled by standards	16x24-bit time dispersive coding (TDC).

Table C-2. Continued

	ISO Layer, Function	Standards Cited	Notes on Interoperability Parameters
1	--Electrical		
	--Voltage Levels	MIL-STD-188-114	[Similar to CCITT V.10/X.26]
	--Load Impedance	MIL-STD-188C	
		MIL-STD-188/24(Prt2)	
		MIL-STD-188-141	
	Mechanical		
	--Connectors	MIL-STD-242G(Prt8)	
		MIL-P-55149	
	Cable Lengths	MIL-STD-242G(Prt8)	
	Functional (pin assign)	MIL-STD-242G(Prt8)	
	Procedural		
	--COMSEC Pre/Postamble		
	Frame Placement	DCT Spec	
	--Keytime Delay	DCT Spec	
	--Bit Synchronization	DCT Spec	
	--Transmission Synch	DCT Spec	
	--Clocking Ctrl & Timing	N/A	

References:

1. Technical Interface Design Plan for Marine Tactical Systems (MTS TIDP), Volume V, Protocol Standard, Headquarters, U.S.Marine Corps, July 1987, UNCLASSIFIED.
2. Discussions with Systems Integration Directorate, MCRDAC, and LOGICON/Eagle Technology, Inc., March 1989.

Table C-3. A Functional Profile of "Datagram" Switched Protocols Used in Tactical Systems by the U.S. Marine Corps

	ISO Layer, Function	Standards Cited	Notes on Interoperability Parameters
7	Msg Header Msg Acknowledgment	None [1] None	• Supports multiple addresses, precedence, and security classification.
6	Msg Format Information Field Size	None None	• Uses the same flagging scheme as the syntax adopted for US JINTACCS K-Series messages • Max is 40 segments, 260 octets per segment (message length)
5	None	N/A	• Null layer
4	End-End Sequence Control End-End Congestion/ Flow Control	None None found	• Transport layer accumulates and orders packets for users; uses 7 octets (vice 20-60 octets for TCP) • Connectionless-oriented layer, a variant of TP4
3	Network Routing/Switching Message Segmenting Packet Addressing Packet Precedence Network Flow & Congestion Control End-End Error Recovery (Message Accountability) Internetting	None found Not controlled by standards None None None found None N/A	• Connectionless-oriented with deterministic routing [2] • Supports "floating" host, using operator-initiated disconnect and reconnect, but requiring no change of address • 260-octet maximum message segment • Uses unique 3-octet routing indicator and provides for multiple addressing for up to 16 destinations • Uses 3 classes of precedence (SysCon, Data1, Data2), in which military precedences (Y-Z-O-P-R) are handled as Data2 • Traffic from subscribers can be limited on precedence; traffic in network is processed by packet precedence • Detects loss of message frames, with notificication for nonperishable messages • Not supported
2	Frame Formatting Frame Addressing Commands & Responses Media Access Data Link Initialization and Release Frame Transfer Acknowledgment (ACK) Retransmission	ISO 3309/7809 (HDLC) with Options 10 and 14 ANSI X3.66-1979 (ADCCP) (MIL188 TRI-TAC Mode VII) ISO 3309 ISO 4335/7809 with addit'l Options 2,4,5,8,11 [5] N/A ISO 4335/7809 ANSI X3.66-1979 (ADCCP) TRI-TAC ICD 16 ISO 4335/7809 ISO 4335 ISO 4335	• Opt 10 calls for extended control field (two octets) • U-frame is extended (two octets) [3] • Opt 14 calls for 32-bit FCS • Station address varies [4] • SIM cmd may be initiated at both stations for link initialization • RIM response not implemented • Does not support poll-final (P/F) bit • When established (initialized), full-duplex point-to-point link has no access contention • Addresses security through use of UI-frames [6] • Uses all 3 types of frames • ACK or NAK is required • Maximum of 5 retries • Retransmission is automatic if no ACK [7]

Table C-3. Continued

ISO Layer, Function		Standards Cited	Notes on Interoperability Parameters
2	ED&C–Error Detection	IS 3309/7809 w Opt 14	• 32-bit FCS (algorithm is ISO 3309, Sec 3.6.3).
	ED&C–Error Coding	Not controlled by standards	• (23,12) half-rate Golay; 24th bit is zero filled (detects 6 and corrects 3 errors in 24 coded bits).
	ED&C--Interleaving	Not controlled by standards	• No time disperal coding (TDC)
1	Electrical		
	--Voltage Levels	MIL-STD-188-114	• [Similar to CCITT V.10/X.26]
	--Load Impedance	MIL-STD-188C	
		MIL-STD-188/24(Prt 2)	
		TT-B1-4204-1101-001	• Conditioned di-phase signalling (TRI-TAC modem-like standard interface)
		MIL-STD-188-141	
	Mechanical		
	--Connectors	MIL-STD-242G(Prt 8)	
		MIL-P-55149	• For binding posts
	--Cable Lengths	MIL-STD-242G(Prt 8)	
	Functional (pin assign)	MIL-STD-242G(Prt 8)	
	Procedural		
	--COMSEC Pre/Postamble Frame Placement	N/A	
	--Keytime Delay (sec)	N/A	• Varies [8]
	--Bit Synchronization	N/A	• 16 bits within keytime delay
	--Transmission Synch	TRI-TAC ICD (U.S.) [8]	• 32-bit transmission synch pattern; • 24-bit transm (16-bit) word count (Golay coded)
	--Clocking Ctrl & Timing	MIL-STD-188-100 (Para 4.3.1.6)	• 16 or 32 Kb/s switch rate

Notes:

1. Where there are standards, but none are cited for this protocol, "None" is used; where there are no applicable standards, "N/A" is used.

2. Profile establishes datagram services, not virtual circuits (CCITT X.25 Packet Layer Protocol is connection oriented).

3. U-frame format agrees with ANSI X3.66 but not with ISO 4335(1987) for extended control field regarding use of second octet. ANSI 3.66 requires a zero-filled (after the poll-final bit) second octet, but ISO 4335 has no extended control field for the U-frame.

4. For link-level frame addressing, TRI-TAC and ISO 3309 (Section 3.2) may be considered as consistent under the following interpretation: whenever one station sends a frame to the other station, the sender's link-level address is 10000000 and the recipient's link-level address is 11000000.

5. ISO 7809 command/response options implemented: Opt 2--adds REJ cmd/resp; Opt 4--adds UI cmd/resp; Opt 5--adds SIM cmd and RM resp [RM resp not implemented]; Opt 8 deletes I-frame for resp. CCITT X.25 LAP B is equivalent to HDLC Options 2, 8 and 10 (only)–this profile incorporates additional HDLC options not permitted by LAP B.

6. Link Initialization Parameter Notified (LIPN) is an application of the UI-frame that provides for six features: Congestion Control, Link Efficiency Control, Crypto ID Coordination of Security, Link Shutdown Notification, Emergency Shutdown Notification, and Orderly Shutdown Notification.

7. Retransmission may be initiated by REJ, NAK, or time out waiting for an ACK. ACK parameters not controlled by standards include: maximum retransmission attempts; and maximum transmissions outstanding without a response (allows for SATCOM delays). This profile allows 5 retransmissions and 18 transmissions outstanding without a response.

8. Keytime delay and transmission synchronization procedures depend on the link encryption hardware selected.

INTERNATIONAL CIVIL STANDARDS RELEVANT TO CCISS[1]

I. OSI ARCHITECTURE AND GENERAL STANDARDS[2]

A. OSI BASIC REFERENCE MODEL AND CONVENTIONS:

STANAG 4250[3] ♦	NATO Reference Model for OSI Part 1--General Description, Revised Draft Part 2--Security, Draft (SANISI Document) Part 3--Naming and Addressing, Draft (Working Paper) Part 4--Management, Draft (Working Document) Part 5--Military Features, Draft (Working Document)
ISO[4] 7498♦	OSI Reference Model - Part 1: Basic Reference Model, General Aspects [SC21 N 3273] AD[5] 1♦ Connectionless-Mode Transmission PDAD[6] 2♦ Multipeer Data Transmission (MPDT) (work suspended)
CD[7] 7498-1	OSI Reference Model - Part 1: General Aspects [Revision, SC21 N 6152]
ISO 7498-2♦	OSI Reference Model - Part 2: Security Architecture
ISO 7498-3♦	OSI Reference Model - Part 3: Naming and Addressing
ISO 7498-4♦	OSI Reference Model - Part 4: Management Framework
TR[8] 8509♦	Service Conventions
DIS[9] 10731	Conventions for Service Definitions, March 1991 [SC21 N 5933] (IS expected March 1992; will supersede TR 8509)
TR 9575	OSI Routing Framework, June 1990

1 Revised March 1991 based on "Status of OSI (and Related) Standards," in *Computer Communication Review*, January 1991, pp. 111-131.
Two BSI documents (*ISO/IEC JTC1/SC21 Project File*, IST21 N 2525, 30 January 1991; and *Project Overview*, IST21 N 2844, 13 June 1991) were major sources for updating the list of standards.

2 The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

3 STANAG: NATO Standardization Agreement

4 ISO: International Standard with final approval from ISO.

5 AD: Addendum for ISO standard.

6 PDAD: Proposed or Preliminary Draft Addendum to ISO standard.

7 CD: Committee Draft for ISO standard [formerly Draft Proposal (DP)].

8 TR: Technical Report for ISO.

9 DIS: Draft International Standard for ISO.

DTR[10] 10730♦	Tutorial on Naming and Addressing, August 1990 [SC21 N 5102] (IS text expected June 1992)
WDTR[11] xxxx	Catalogue of PICS Proforma Notations, July 1991 (joint work of WG1 and CCITT SG VII; meeting scheduled for February 1991) [SC21 N 6160]
IST18[12] N 2694	Final Report on the Framework for Open Systems, July 1990
IST21 N 2508	PICS Proforma Notations, January 1991
IST21 N 2551	UK Response to SC21 N 5110 on the Technical Structure of Quality-of-Service (QOS) Architecture, February 1991
IST21 N 2553	Proposed UK Contribution on QOS, Joint Meeting on QOS, January 1991
IST21 N 2860	EWOS Technical Guide Routeing in the Context of OSI, EWOS-EGLL9172, Final Draft, 27 May 1991
SC5 N 220[13]	Interim Report of the TCCA Rapporteurs' Group of Time-Critical Communications Architecture and Systems, 15 April 1991
SC6 N 4782	An Architectural Framework for Private Networks, Pre-Publication Version of ECMA TR 44, December 1987
SC21 SD-9[14]	Approved Commentaries on the Basic Reference Model for Open Systems Interconnection, SC21 OSI Reference Model Editor, July 1991 [SC21 N 6198]
SC21 N 2524	SC21/WG1 Overview - OSI Architecture, 29 January 1991
SC21 N 3207	Relationship Between Objects in Peer Open Systems, December 1988 [SC21/WG6]
SC21 N 3711	Requirements for Multipeer Data Transmission, July 1989
SC21 N 3906	Final Report to SC21 in Florence on the Reassessment of Project JTC 1.21.9.1 on Multipeer Data Transmission, October 1989
SC21 N 4647	Requirements for Service Conventions, May 1990
SC21 N 4681	User Requirements for Multi-Party Communications (MPC), Canada, May 1990
SC21 N 4682	Establishment of User Requirements, Canada, May 1990
SC21 N 4763	On-Going Multipeer Projects Within JTC1, ANSI, May 1990
SC21 N 5017	Relationship Between Concepts and Models for OSI and ODP, SC21/WG6, July 1990
SC21 N 5073	Final Answer to Q1/30.5 on Definition of the Term "Quality of Service," SC21/WG1, May 1990
SC21 N 5074	Final Answer to Q1/330.6 on Relay, Routing, and Network Management, SC21/WG1, May 1990
SC21 N 5081	Draft Answer to Q1/61 on Consistency Among ISO Standards Related to the OSI Reference Model, May 1990
SC21 N 5093	Status and Method of Operation for the Reference Model Revision, SC21/WG1, May 1990
SC21 N 5095	Liaison to SC6 on Revision of the Reference Model, May 1990

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10 DTR: Draft Technical Report for ISO.

11 WDTR: Working Draft Technical Report for ISO.

12 IST: Committee of the British Standards Institute (e.g., IST21 is associated with SC21).

13 Selected working drafts (e.g., SC6 N 4782) have been included from ISO/IEC JTC1 Subcommittee (SC) 5, SC6, SC18, SC20, SC21, SC22, and the Special Group on Functional Standardization (SGFS). These and other JTC1 standards organizations are discussed in Appendix F.

14 SD: Standing Document for an ISO subcommittee.

SC21 N 5096	Liaison to CCITT SG VII on Revision of the Reference Model, June 1990
SC21 N 5099	Liaison Statement to CCITT SG VII(Q.25) on Service Conventions, SC21/WG1, May 1990
SC21 N 5105	Final Answer to Q1/56.6.1 on Positioning of Circuit Switched Networks, SC21/WG1, May 1990
SC21 N 5109	Liaison Statement to CCITT SG VII(Q23) on Naming and Addressing, SC21/WG1, May 1990
SC21 N 5110	Call to National Bodies and Liaison Organizations for Contributions on Technical Structure of Quality of Service (QoS) Architecture, May 1990
SC21 N 5196	Report of the Special Meeting on User Requirements, SC21, 7 June 1990
SC21 N 5197	Report of the Standards Maintenance Group, SC21, 4 June 1990
SC21 N 5501	Working Draft of Revised ISO 7498-1 Clauses 7.1 - 7.3, Information Transfer, Retrieval and Management for Open Systems [SC21/WG1, November 1990]
SC21 N 5840	Comments on the Relationship Between Concepts and Models for OSI and ODP, USA, April 1991
SC21 N 5849	USA Requirements to Reactivate the Multipeer Data Transmission Project (JTC 1.21.09.01), USA, April 1991
SC21 N 5933	Conventions for the Definition of OSI Services, DIS 10731, 1991
SC21 N 5934	Collection of Definitions of OSI Vocabulary (April 1991 Version), Rapporteur on Q17: OSI Vocabulary, June 1991
SC21 N 6158	Final Answer to Q1/62 (Quality of Service Architectural Issues), WG1, May 1991
SC21 N 6159	Framework on Quality of Service, WG1, May 1991
SC21 N 6160	Catalogue of PICS Proforma Notations, WG1, July 1991
SC21 N 6197	WG1 Position on the Reactivation of Project 1.21.9.1 (Multi-Peer Data Transmission), WG1, July 1991 (national body comments requested by 31 March 1992)
SC21 N 6198	Approved Commentaries on the OSI Basic Reference Model [SC21 SD-9], July 1991
CCITT X.200	Reference Model of OSI for CCITT Applications
CCITT X.210	OSI Layer Service Definition Conventions

B. WORK PLANS AND COORDINATION AGREEMENTS:

IST21 N 2393	Proposals for Corrigenda to OSI Standards - Reprint from BSI News, November 1990
IST21 N 2670	Prospective vs Traditional Standardization, March 1991
IST21 N 2754	Extension of M-IT-01 and M-IT-02 for the Open System Environment, European Workshop for Open Systems, EWOSTA9181, April 1991
IST21 N 2766	March 1991 Resolutions RWS-CC, May 1991
IST21 N 2769	Summary of EWOS Contribution to JTC1 SGFS, June 1991, May 1991
IST21 N 2770	AD HOC Meeting on an Open Systems Framework, May 1991
JTC1 N 1260	SC21 Request to Modify its Programme of Work, ISO/IEC JTC1, March 1991
JTC1 N 535	Directives for the Work of ISO/IEC Joint Technical Committee 1 (JTC1) on Information Technology, Secretariat, August 1989
JTC1 N 598	JTC1 Strategic Plan, Editing Team, November 1989

SGFS[15] N 151	CCITT Liaison Statement on Work of SGFS, November 1989 (includes X.220)
SGFS N 225	Resolutions of JTC1 Advisory Group, June 1990
SGFS N 229	Resolutions of the 3rd Regional Workshop Coordinating Committee Meeting; AOW - EWOS - NIST OIW, June 1990
SGFS N 236	EWOS Organization and Activities, June 1990
SGFS N 282	Resolutions of the 4th RWS-CC Meeting, 18-19 October 1990, January 1991
SGFS N 300	List of documents (N 182 - N 300), Secretariat, February 1991
SGFS N 373	Output from the 5th Regional Workshop Coordinating Committee (RWS-CC), March 18-19, 1991, 13 June 1991
SC21 SD-1	Report of the Secretariat to the Plenary Meeting of ISO/IEC JTC1 SC21, 5-6 June 1990, Seoul, Republic of Korea, SC21 Secretariat, April 1990 [SC21 N 4588] (provides terms of reference and points of contact for working groups)
SC21 SD-2	ISO/IEC JTC1 SC21 Programme of Work (POW) - Target Date Summary for All Active and Published Projects, SC21 Secretariat, April 1990
SC21 SD 7	Security Management Plan, 4 June 1990 [SC21 N 5130]
SC21 SD-8	Schedule of Meetings, SC21, June 1991 [SC21 N 6261]
SC21 N 2525	IST/21 Project File: January 1991, January 1991
SC21 N 3122	Informal Guide for ISO/IEC JTC1 and CCITT Cooperation, January 1989
SC21 N 3205	Proposed Modus Operandi and Programme of Work of SC21/WG6 ULA Rapporteur Group, December 1988 [SC21/WG6]
SC21 N 4758	Request to ISO/IEC SC21 from OSF for Establishment of Liaison Relationship, May 1990
SC21 N 4801	Liaison Statement to SC21 on Joint Efforts Between SG VII(Q20) and SG I(Q16), CCITT SG I(Q.16), May 1990
SC21 N 4903	Methodology and Guidelines for the Development of Application Layer Standards, SC21/WG6, June 1990
SC21 N 5071	Recommendations Approved by SC21/WG1 at its Seoul Meeting, 23-31 May 1990, SC21/WG1, May 1990
SC21 N 5072	List of Output Documents of SC21/WG1 Meeting, Seoul, 23-31 May 1990, SC21/WG1, July 1990
SC21 N 5131	Recommendations of the SC21/WG6 Meeting, 23 May - 1 June 1990, Seoul, SC21/WG6, June 1990
SC21 N 5136	Recommendations of SC21/WG3 Meeting in Seoul, May/June 1990, SC21/WG3, June 1990
SC21 N 5154	Recommendations of the SC21/WG5 Meeting, Seoul, 24 May - 1 June 1990, SC21/WG5, June 1990
SC21 N 5194	Resolutions of the Fourth Plenary Meeting of SC21, 5 June 1990, Seoul, SC21, June 1990
SC21 N 5203	SC21/WG1 Convenor's Report to SC21 Plenary Meeting, Seoul, 5-6 June 1990, SC21/WG1, June 1990
SC21 N 5219	Draft Management Guidelines for SC21, Rapporteur for Strategic Planning, July 1990
SC21 N 5228	Report of the ISO/IEC JTC1/SC21 Plenary Meeting, 5 June 1990, Seoul, Korea, July 1990

[15] SGFS: Special Group on Functional Standardization [develops International Standard Profiles (ISPs)].

SC21 N 5229	Report of the JTC1/SC21 Plenary Meeting, 5 June 1990, Seoul, Republic of Korea
SC21 N 5337	EWOS Organizations and Activities, 9 October 1990, EWOS
SC21 N 5505	Liaison to CCITT Q23/VII and Q19/VII, ISO/IEC JTC WG6 ULA, November 1990
SC21 N 5599	Notice of and Draft Agenda for the ISO/IEC JTC1/SC21 Meeting, 4 & 5 June 1991, Arles, France, SC21 Secretariat, February 1991
SC21 N 5605	Subcommittee Report to the ISO/IEC JTC 1 Advisory Group Meeting, 19 - 21 February 1991, Washington, D.C., USA, January 1991
SC21 N 5830	SC21 Standards Maintenance, AFNOR, April 1991
SC21 N 6060	Proposed Draft Answer to Question Q6/1--Versions and Extensibility, SG6, May 1991
SC21 N 6018	Resolutions of the Eighth SC21/WG4 Meeting, Arles, 20-27 May 1991, 20 June 1991
SC21 N 6019	Minutes of the Eighth SC21/WG4 Meeting, Arles, 20-27 May 1991, May 1991
SC21 N 6020	SC21/WG4 Convenor's Report to the ISO/IEC JTC1/SC21 Plenary Meeting, Arles, June 1991, 20 June 1991
SC21 N 6023	Work Plan for SC21/WG4 Systems Management, 20 June 1991
SC21 N 6061	Progression of Methodology and Guidelines for the Development of Application Layer Standards, WG6, June 1991
SC21 N 6204	List of Late Contributions and Output Documents of SC21/WG1 Arles Meeting, 22-30 May 1991, May 1991
SC21 N 6210	Recommendations Approved by the ISO/IEC JTC1/SC21/WG1 at its Arles Meeting, 22-30 May 1991, May 1991
SC21 N 6217	Recommendations of the ISO/IEC JTC1/SC21/WG5 Meeting, Arles, 23-31 May 1991, June 1991
SC21 N 6248	Resolutions of the ISO/IEC JTC1/SC21/WG6 Meeting, 22-31 May 1991, Arles, France, 10 June 1991
SC21 N 6273	Resolutions of the Seventh Plenary Meeting of ISO/IEC JTC1/SC21, 4-5 June 1991, Arles, France, 20 June 1991
SC21 N 6275	Plan to Mechanize the ISO/IEC JTC1 Secretariat (SC21 Pilot Project), June 1991

C. FORMAL DESCRIPTION TECHNIQUES (FDTs):

ISO 8807♦	LOTOS - A Formal Description Technique Based on the Temporal Ordering of Observational Behavior	
	DAM[16] 1	Graphical Representation of LOTOS (G-LOTOS) (new work item proposal of December 1989 not accepted; status uncertain) [SC21 N 4871]
ISO 9074♦	Estelle - A Formal Description Technique Based on an Extended State Transition Model	
	DAM 1♦	Estelle Tutorial [SC21 N 5710] May 1991 (IS text expected June 1992)
TR 10167	Guidelines for the Application of Estelle, LOTOS, and SDL [SC21 N 4259]	

[16] DAM: Draft Amendment for an ISO standard (has the status of a DIS).

CDTR xxxx♦	Architectural Semantics for FDTs, Revised Draft, July 1990, SC21/WG1 [SC21 N 5116]
SC21 N 3132	TTCN Operational Semantics, November 1988
CCITT X.250	Formal Description Techniques for Data Communications Protocols and Services
CCITT Z.100	Specification and Description Language (SDL)
CCITT Z.110	Criteria for the Use and Applicability of Formal Description Techniques

D. SECURITY:

ISO 8372	Modes of Operation for a 64-bit Block Cipher Algorithm, 1987
ISO 9160	Physical Layer Interoperability Requirements, 1988
DIS 9796	Digital Signature Scheme Giving Message Recovery, 1989
ISO 9797	Data Integrity Mechanisms Using a Cryptographic Check Function Employing a Block Cypher Algorithm, 1989
DIS 9798-1	Entity Authentication Mechanisms - Part 1: General Model
DP[17] 9798-2	Entity Authentication Mechanisms - Part 2: Entity Authentication Mechanisms Using Symmetric Algorithms
ISO 9979	Procedures for the Registration of Cryptographic Algorithms, July 1990 [SC27 N 88]
DIS 10116	Modes of Operation for an N-bit Block Cipher Algorithm, 1989 [SC27 N 86]
WD[18] 10181-1♦	Security Frameworks in Open Systems - Part 1: Overview, July 1991 [SC21 N 6166] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
DIS 10181-2	Security Frameworks in Open Systems - Part 2: Authentication Framework, May 1991 [SC21 N 5727] (IS status expected in March 1992)
	WDAM 1 Authentication Elements, July 1991 [SC21 N 6172]
CD 10181-3♦	Security Frameworks in Open Systems - Part 3: Access Control Framework, July 1991 [SC21 N 6168] (DIS text expected in March 1992; IS status in December 1992)
WD 10181-4♦	Security Frameworks in Open Systems - Part 4: Non-Repudiation Framework, July 1991 [SC21 N 6165] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
WD 10181-5♦	Security Frameworks in Open Systems - Part 5: Confidentiality Framework, July 1991 [SC21 N 6164] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
WD 10181-6	Security Frameworks in Open Systems - Part 6: Integrity Framework, July 1991 [SC21 N 6163] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
CD 10181-7	Security Frameworks in Open Systems - Part 7: Security Audit Framework, July 1991 [SC21 N 6169] (DIS text expected in March 1992; IS status in December 1992)
WD 10181-8	Security Frameworks in Open Systems - Part 8: Key Management
CD 10745	Upper Layer Security Model, June 1991 [SC21 N 6095] (CD ballot closes 22 October 1991)

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17 DP: Draft Proposal for an ISO standard [to be issued as Committee Drafts (CDs) beginning in 1990].

18 WD: Working Draft for ISO (status of text prior to being submitted as a Committee Draft).

WD xxxx-1	Cryptographic Mechanisms for Key Management, Part 1: Key Management Overview [SC27/WG2]
WD xxxx-2	Cryptographic Mechanisms for Key Management, Part 2: Key Management Using Secret Key Techniques [SC27/WG2]
WD xxxx-3	Cryptographic Mechanisms for Key Management, Part 3: Key Management Using Public Key Techniques [SC27/WG2]
WD xxxx-4	Cryptographic Mechanisms for Key Management, Part 4: Key Management Using Public Key Register [SC27/WG2]
IST21 N 2478	Catalogue of Security Related Projects for Consideration at the JTC 1 Workshop on Security 5-7 November 1990, May 1990
IST21 N 2852	POSIX Security Call for New Work Items, SC22/WG15, June 1991
JTC1 N 996	IST/21 N 2478, Catalogue of Security Related Projects for consideration at the JTC 1 Workshop on Security 5-7 November 1990, May 1990
JTC1 N 1011	Results of National Body Survey for Consideration at the JTC1 Workshop on Security, 5-7 November 1990, London, 10 October 1990
JTC1 N 1015	ISO/IEC JTC1/SC21 Presentation Materials for the Workshop on Security (Topic: Security for OSI Management), 10 October 1990
JTC1 N 1016	ISO/IEC JTC1/SC21 Presentation Materials for the Workshop on Security (Topic: OSI Security Architecture and Security Frameworks), 10 October 1990
SC6 N 6219	Liaison to SC21 on Lower Layer Security, ISO/IEC/JTC1/SC6, October 1990
SC6 N 6221	Draft Network Layer Security Protocol, SC6/WG2, September 1990 (incomplete editor's Draft B)
SC6 N 6227	Lower Layer Security Guidelines, SC6/WG2/WG4, September 1990
SC6 N 6285	Working Draft OSI Transport Layer Security Protocol, SC6/WG4, September 1990
SC21 N 2555	Work in Security Within SC21, Gray Girling, February 1991
SC21 N 2652,	Security Features in International Standards Profiles (ISPs), E.J. Humphreys, Chair of IST33, March 1991
SC21 N 3141	Response to SC21 N 2864, Issues Concerning the Requirements for Security Services in the Presentation Layer, November 1988 [SC21/WG1]
SC21 N 3167	Response to SC18 Liaison on Encryption, January 1989 [SC21/WG3]
SC21 N 3266	Guide for Open Systems Security, December 1988 [SC21/WG1]
SC21 N 3267	Plan for Work on Security in SC21, December 1988 [SC21/WG1]
SC21 N 3283	Working Draft for Lower-Layer Security Model, December 1988 [SC21/WG1]
SC21 N 3337	Security Management Domain and Security Policies
SC21 N 3991	Security Exchange Service Element, CCITT Q19/VII(DAF), November 1989 (CD text in SC21/WG6 expected in 1992)
SC21 N 4526	Application Layer Security Considerations, Workshop of Distributed Applications, April 1990
SC21 N 4648	Security and Security Exchange Information, February 1990, Canadian contribution to SC21/WG6
SC21 N 4833	Report to JTC1 from SC27 on Security Techniques, SC27 Secretariat, 21 May 1990 [SC27 N 94]
SC21 N 4834	Liaison Statement from SC27 to JTC1 Advisory Group, SC27 Secretariat, 21 May 1990 [SC27 N 93]
SC21 N 4835	Report of the First Plenary Meeting of SC27 at Stockholm, 24-26 April 1990, SC27 Secretariat, 21 May 1990 [SC27 N 92]

SC21 N 4836	Resolutions Taken at the First Plenary Meeting of SC27 at Stockholm, 24-26 April 1990, 21 May 1990 [SC27 N 94]
SC21 N 4980	Security Audit Framework Working Document, SC21/WG4, July 1990
SC21 N 5001	Upper Layers Security Model, Third Working Draft, SC21/WG6, June 1990
SC21 N 5002	Commencement of Work on Security ASEs, SC21/WG6, May 1990
SC21 N 5003	Distributed Applications Security Modelling and Infrastructure, SC21/WG6, July 1991
SC21 N 5054	Working Document on Presentation Service to Give Confidentiality and Integrity Protection, SC21/WG6, July 1990
SC21 N 5346	U.S. Contribution on the Upper Layer Security Model (ULSM), October 1990 [SC21 N 5001]
SC21 N 5347	U.S. Contribution on the Security Frameworks Overview, November 1990 [SC21 N 5044]
SC21 N 5348	U.S. Contribution on the Access Control Framework, November 1990 [SC21 N 5045]
SC21 N 5349	U.S. Contribution on the Non-Repudiation Framework, November 1990 [SC21 N 5046]
SC21 N 5447	The Upper Layers Security Model, fourth working draft, 30 October 1990 (CD text expected in 1991)
SC21 N 5448	Outline Working Draft for Part 1 of Generic Security Exchange ASE Definition, ISO/IEC, October 1990
SC21 N 5503	Response to Liaison Statement SC21 N 5453 on ULA Issues Arising in Security Work, ISO/IEC WG6 ULA, January 1991
SC21 N 5504	Response to Liaison Statement to WG 6 ULA and Upper Layers Security Groups [SC21/WG6 N 906], ISO/IEC WG6 ULA, January 1991
SC21 N 5529	Working Draft Access Control Framework, ISO SC21/WG1, February 1991
SC21 N 5530	Working Draft Confidentiality Framework, SC21/WG 1/CCITT, January 1991
SC21 N 5531	Working Draft Integrity Framework, SC21/WG 1/CCITT, January 1991
SC21 N 5532	Working Draft Security Frameworks Overview, SC21/WG 1/CCITT, January 1991
SC21 N 5533	Guide to Open Systems Security, SC21/WG1, 3 January 1991
SC21 N 5555	Liaison Statement to ISO/IEC JTC 1/SC 21 on Lower Layer Security, SC6, January 1991
SC21 N 5575	Request for National Body Comment, SC21/WG1/CCITT, January 1991
SC21 N 5576	Rapporteur's Report of the SC21/WG1/CCITT Collaborative Meeting on Security Frameworks, January 1991
SC21 N 5580	New Area of Work for SC27/WG1 on IT Security Information Objects, 7 January 1991
SC21 N 5581	New Area of Work for SC27/WG1 on IT Security Terminology, 7 January 1991
SC21 N 5731	Progression of the Upper Layers Security Standards, Canada, April 1991
SC21 N 5732	Use of Presentation Layer in Providing Confidentiality/Integrity, Canada, April 1991
SC21 N 5733	Proposed ASN.1 Useful Type to Support Presentation Layer Confidentiality/Integrity, Canada, April 1991
SC21 N 5734	Proposed Working Draft for Part 2 of Generic Security Exchange ASE Definition, Canada, April 1991

[19]SC21 N 5757	Work on Security Within SC21, UK, March 1991
SC21 N 5904	Liaison Statement to JTC 1/SC 18, SC21 and SC 27 - Tracking of Existing and New Security Related Work Items, ISO/TC 68/SC 2, April 1991
SC21 N 6037	Need for Security Services with OSI Management, SG4, July 1991
SC21 N 6096	Working Draft of Security Exchange ASE - Part 1: Security Exchange Model and Specification Framework, WG6, June 1991 [Part 2: Security Exchange ASE Service Definition; Part 3: Security Exchange ASE Protocol Specification; and Part 4: Security Exchange ASE PICS Proforma]
SC21 N 6097	Working Draft of Security Exchange ASE - Part 2: Security Exchange ASE Service Definition, WG6, June 1991
SC21 N 6098	Working Draft of Security Exchange ASE - Part 3: Security Exchange ASE Protocol Specification, WG6, June 1991
SC21 N 6099	Authentication Services for Distributed Applications, WG6, 1 July 1991 [WD 5/91, CD 5/92, DIS 5/93, IS 5/94], JTC1 N 1437, July 1991 (new work item)
SC21 N 6130	Working Draft for ASN.1 Encoding Rules to Provide Upper Layer Security and Compression, WG6, June 1991
SC21 N 6167	Revised Draft Guide to Open Systems Security, WG1, July 1991
SC21 N 6172	Security Enhancement to Directory (Extension to ISO/IEC 9594-8), WG1, July 1991 (new work item)

E. OSI MANAGEMENT:

ISO 9595:1991(E)♦		Common Management Information Service (CMIS) Definition, April 1991 CCITT X.710 [SC21 N 5302] (April 1991 edition incorporates AD1 and AD2)
	PDAM[20] 3	Support of Allomorphism, November 1990 [SC21 N 4966] (PDAM expected June 1993, IS in March 1994, IS in March 1995)
	PDAM 4	Access Control, July 1991 [SC21 N 6286] (IS status expected in June 1992)
ISO 9596–1		Common Management Information Protocol (CMIP) Specification, April 1991 (CCITT X.711) [SC21 N 5303] (April 1991 edition incorporates AD1 and AD2)
	PDAM 3	Support of Allomorphism, July 1990 [SC21 N 4967] (CD text expected November 1990)
	PDAM 4	State Table (new work item June 1990; cancelled June 1991)
	WDAM 5	Access Control
DIS 9596–2		Common Management Information Protocol (CMIP) Specification, Part 2: PICS Proforma, July 1991 [SC21 N 6287] (CCITT X.712) (IS status expected June 1992)
ISO 10040♦		Systems Management Overview, August 1991 [SC21 N 4865, September 1990] (CCITT X.701)
ISO 10164-1♦		Systems Management - Part 1: Object Management Function, July 1991 [SC21 N 4855, September 1990] (CCITT X.730)
ISO 10164-2♦		Systems Management - Part 2: State Management Function, July 1991 [SC21 N 4856, September 1990] (CCITT X.731)
ISO 10164-3♦		Systems Management - Part 3: Relationship Management Function, July 1991 [SC21 N 4857, September 1990] (CCITT X.732)

19 WDAM: Working Draft Amendment to an ISO Standard (has the status of a WD).

20 PDAM: Proposed Draft Amendment to an ISO Standard (has the status of a CD).

ISO 10164-4♦	Systems Management - Part 4: Alarm Reporting Function, July 1991 [SC21 N 4858, September 1990] (CCITT X.733)
ISO 10164-5♦	Systems Management - Part 5: Event Report Management Function, July 1991 [SC21 N 4860, September 1990] (CCITT X.734)
ISO 10164-6♦	Systems Management - Part 6: Log Control Function, July 1991 [SC21 N 4862, September 1990] (CCITT X.735)
ISO 10164-7♦	Systems Management - Part 7: Security Alarm Reporting Function, July 1991 [SC21 N 4874, September 1990] (CCITT X.736)
DIS 10164-8	Systems Management - Part 8: Security Audit Trail Function, July 1991 [SC21 N 6283] (CCITT X.740) (IS status expected in June 1992)
CD 10164-9.2	Systems Management - Part 9: Objects and Attributes for Access Control, June 1991 [SC21 N 5764] (CCITT X.741) (second CD ballot ends October 1991; DIS text expected December 1991, IS in December 1992)
CD 10164-10.2	Systems Management - Part 10: Accounting Meter Function, July 1991 [SC21 N 5648] (CCITT X.742) (second CD ballot expected in 1991; DIS text expected in March 1992, IS in March 1993)
CD 10164-11.2	Systems Management - Part 11: Workload Monitoring Function, May 1991 [SC21 N 5767] (CCITT X.739) (DIS text expected in 1991; DIS text expected December 1991, IS in December 1992)
CD 10164-12	Systems Management - Part 12: Test Management Function, May 1991 [SC21 N 5517] (CCITT X.745) (DIS text expected October 1991, IS in December 1992)
CD 10164-13	Systems Management - Part 13: Summarization Function, May 1991 [SC21 N 5519] (CCITT X.738) (DIS text expected in October 1991, IS in December 1992)
WD 10164-X	Systems Management - Part X: Software Management Function, July 1991 [SC21 N 6040] (CD text expected June 1993, DIS in March 1994, IS in March 1995) (CCITT X.744)
WD 10164 -cdt	Systems Management - Part cdt: Confidence and Diagnostic Test Classes, December 1990 [SC21 N 5518] (CD text expected December 1991, DIS in August 1992, IS in August 1993) (CCITT X.737)
WD 10164-A	Systems Management - Part A Time Management Function, July 1990 [SC21 N 4953] (CD text expected June 1993, DIS in March 1994, IS in March 1995) (CCITT X.743)
WD 10164-sm	Systems Management Relationship Model, June 1991 [SC21 N 6041] (CD expected in December 1992, DIS in August 1993, IS in August 1994)
WD 10164-rtm	Response Time Monitoring, August 1990 [SC21 N 4949; JTC1 N 963] (CD text expected December 1993, DIS in August 1994, IS in August 1995)
WD 10164-s	Systems Management - Part s: Scheduling Function, June 1991 [SC21 N 6021] (CD text expected June 1992, DIS in March 1993, IS in March 1994)
DIS 10165-1♦	Structure of Management Information - Part 1: Management Information Model, September 1990 [SC21 N 5252] (DIS ballot failed 22 April 1991, but editing meeting in May 1991 recommended progression to IS) (CCITT X.720)
DIS 10165-2♦	Structure of Management Information - Part 2: Definition of Management Information, September 1990 [SC21 N 4867] (IS text expected late 1991) (replaces original parts 2 and 3) (CCITT X.721)
DIS 10165-4♦	Structure of Management Information - Part 4: Guidelines for the Definition of Managed Objects, September 1990 [SC21 N 4852] (DIS ballot failed 22 April 1991, but editing meeting in May 1991 recommended progression to IS) (CCITT X.710)

CD 10165-5	Structure of Management Information - Part 5: Generic Management Information, July 1991 [SC21 N 6025] (DIS text expected in March 1992, IS in March 1993) (previously entitled Generic Managed Objects)
CD 10165-6	Structure of Management Information - Part 6: Requirements and Guidelines for Management Information Conformance Statement (MICS) Proformas, July 1991 [SC21 N 6027] (DIS text expected in March 1992, IS in March 1993)
WD 10165-7	Structure of Management Information - Part 7: Management Information Register and Registration Procedures (CD expected in June 1992, DIS in December 1992, IS in December 1993)
CD 10733	Telecommunications and Information Exchange Between Systems - Elements of Management Information Related to OSI Network Layer Standards [SC21 N 5560, 3 January 1991; SC6 N 6413, 11 December 1990]
WD xxxx(E)	Managed Object Conformance Statement (MOCS) Proforma [SC21 N 5686, February 1991]
WDTR xxxx	Systems Management Tutorial, July 1990, SC21/WG4 [SC21 N 4942] (new work item) (CCITT X.702)
WDTR xxxx, Annex A	Systems Management Tutorial - Annex A: Access Control, May 1990 [SC21 N 4970]
SC6 N 5447	Liaison Statement to SC21/WG4 on Lower Layer Management, October 1990
SC6 N 5784	General Principles for the Definition of Lower Layer Management, Second Draft, JTC1 SC6/WG2/WG4, April 1990
SC6 N 6413	Elements of Management Information Related to OSI Network Layer Standards, December 1990 (see CD 10733]
SC21 N 3307	WG4 Architecture Issues List
SC21 N 3311◆	Configuration Management Overview
SC21 N 3316	Access Control for OSI Management and The Directory
SC21 N 4058	State Tables for CMIP, January 1990
SC21 N 4077◆	Fault Management Working Document, SC21/WG4, December 1989
SC21 N 4085◆	Accounting Management Working Document, Third Version, SC21/WG4, November 1989
SC21 N 4091◆	OSI Security Management Working Document, November 1989
SC21 N 4906	Upper Layer Management - Call for Contributions, SC21/WG6, June 1990
SC21 N 4943	Extended Systems Management Architecture, July 1990 (planned to be an amendment to DIS 10040)
SC21 N 4944	Generic Managed Objects, July 1990
SC21 N 4945	Definition of a Management Information Register and Registration Procedures, July 1990
SC21 N 4946	Requirements and Guidelines for Managed Object Conformance Statement (MOCS) Proformas, July 1990
SC21 N 4947	Formal Descriptions of CMIP, July 1990
SC21 N 4948	Systems Management Relationship Model, July 1990 (expected to use entity-relationship modelling)
SC21 N 4949	Systems Management: Response Time Monitoring, July 1990
SC21 N 4953	Time Management: Representation of Time, SC21/WG4, July 1990
SC21 N 4960	Generic Managed Objects, Working Draft, SC21/WG4, July 1990
SC21 N 4961	Request for Contributions to Progress Work on the Definition of State Tables for CMIP, May 1990

SC21 N 4968	Synchronization Across Multiple Managed Objects, SC21/WG4, July 1990
SC21 N 4969	Call for National Body Contributions on Time Management, SC21/WG4, May 1990
SC21 N 4973	The Use of System Title by OSI Management, SC21/WG4, July 1990
SC21 N 4974	Use of Global Naming for Identification of Managed Objects, SC21/WG4, July 1990
SC21 N 4975	A General Model for Relationship Management, SC21/WG4, May 1990
SC21 N 4977	Use of Action to Invoke State Changes, SC21/WG4, July 1990
SC21 N 4979	Request for National Body Comment on the Need for an Access Control Information Management Function, SC21/WG4, May 1990
SC21 N 4981◆	Performance Management Working Document, Sixth Working Draft, July 1990
SC21 N 4982	WG4 Systems Management Issues, SC21/WG4, July 1990
SC21 N 5079	Draft Answer to Q1/63.1 on Conformance to Objects in the Context of OSI Management, SC21/WG1, May 1990
SC21 N 5080	Call for Contributions on OSI Management Conformance Issues, SC21/WG1, July 1990
SC21 N 5228	Proposed Technical Corrigenda to ISO 9595 and ISO 9596
SC21 N 5543	Planning and Organization of SC21/WG4 Systems Management Activities, November 1990
SC21 N 5544	Call for Input on the Work Plan for SC21/WG4, November 1990
SC21 N 5545,	Working Draft Input on Scheduling for Management Functions, OSI, 12-23 November 1990
SC21 N 5546	Agreement on Planning Future Releases of CMIS/P, OSI, November 1990
SC21 N 5557	Liaison Statement to ISO/IEC JTC1/SC21/WG1 on SC6 PICS Proforma Guidelines, SC6, January 1991
SC21 N 5548	Issues Concerning the Management Information Model and GDMO, OSI, 12-23 November 1990
SC21 N 5549	Preliminary Consideration of New Work Items Relating to SMI, OSI, 12-23 November 1990
SC21 N 5551	Work Plan for Managed Objects Standardization, OSI, November 1990
SC21 N 5560	Liaison Statement to WG4 Concerning SMI-related Issues, SC6, January 1991
SC21 N 5606	Working Draft for [Information Technology - Open Systems Interconnection - Structure of Management Information - Part X:] Generic Managed Objects [for CCITT Applications], March 1991
SC21 N 5687	Management Information Registration Procedure, ISO CCITT, February 1991
SC21 N 5756	The Proliferation of Managed Objects, UK, March 1991
SC21 N 5803	Extended Relationship Management, USA, March 1991
SC21 N 5815	A General Model for Managed Object Relationships, Canada, March 1991
SC21 N 5891	Contribution to the New Work Item: Management Information Register and Registration Procedures, Germany, 16 April 1991
SC21 N 6029	Proposal for the Establishment of a Managed Object Advisory Group, WG4, June 1991
SC21 N 6035	Enhanced Event Management and Log Control, WG4, July 1991 (new work item)
SC21 N 6037	Need for Security Services with OSI Management, SG4, July 1991

SC21 N 6039	Development of Enhanced Functionality for CMIS/P, WG4, July 1991 [CD expected in 1993, DIS in 1994, IS in 1995], JTC1 N 1438 (voting ends October 1991) (new work item)
SC21 N 6040	OSI Software Management - Working Draft, WG4, June 1991
SC21 N 6041	General Relationship Model--Working Draft, WG4, June 1991
SC21 N 6046	Response to Systems Management Tutorial NWI Proposal Ballot (contains initial May 1991 draft of the Systems Management Tutorial), WG4, June 1991
SC21 N 6047	First Working Draft on Management Domains, WG4, June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6048	Working Document on Management Knowledge Management, WG4, June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6049	Working Document on Synchronization, WG4, June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6194	Final Answer to Q1/63.1--Meaning of Conformance to Objects in the Context of OSI Management, WG1, May 1991
SC21 N 6196	PICS Issues (Part 7 to ISO/IEC 9646), WG1, July 1991

F. OSI REGISTRATION AUTHORITIES:

DIS 9834-1♦	Procedures for Specific OSI Registration Authorities - Part 1: General Procedures, March 1990 [SC21 N 4352] (DIS ballot closed February 1991; IS expected August 1991)
ISO 9834-2♦	Procedures for Specific OSI Registration Authorities - Part 2: Registration Procedures for Document Types, November 1990 [SC21 N 5275] (approved June 1991; IS text expected in late 1991)
ISO 9834-3♦	Procedures for Specific OSI Registration Authorities - Part 3: Procedures for Specific Registration of Joint Object Identifier Component Values for Joint ISO-CCITT Use, September 1990 [SC21 N 4718]
ISO 9834-4♦	Procedures for Specific OSI Registration Authorities - Part 4: Registration of VTE Profiles, July 1991 [SC21 N 4325, 10 January 1990]
ISO 9834-5♦	Procedures for Specific OSI Registration Authorities - Part 5: Register of VT Control Object Definitions, July 1991 [SC21 N 4322, 10 January 1990]
DIS 9834-6	Procedures for Specific OSI Registration Authorities - Part 6: Registration Authority Procedures for Application Process Titles and Application Entity Titles, September 1990 [SC21 N 5218] ((DIS ballot failed 25 April 1991))
WD 9834-B	Procedures for Specific OSI Registration Authorities - Part B: Registration of Abstract Syntaxes, 1990
WD 9834-C	Procedures for Specific OSI Registration Authorities - Part C: Registration of Transfer Syntaxes, 1990
WD 9834-D	Procedures for Specific OSI Registration Authorities - Part D: Registration of Application Contexts (work suspended by SC21, November 1989)
WD 9834-E	Procedures for Specific OSI Registration Authorities - Part E: Registration of System Titles, 1990 (will probably be incorporated in OSI management standards)
WD 9834-F	Procedures for Specific OSI Registration Authorities - Part F: Registration of Authentication Mechanisms (WITHDRAWN; cancelled by SC21, November 1989)
TR 9973	Registration of Graphical Items
WD xxxx	Registration of System Titles (DP expected November 1990)

SC21 N 5014	Liaison Statement to CCITT SG VII (Q.23) on Collaborative Work on OSI Registration, June 1990
SC21 N 5687	Management Information Registration Procedure, Working Draft, February 1991
SC21 N 5758	Discussion Paper on Conformance and Registration, BSI, March 1991
SC21 N 5891	Contribution to the New Work Item: Management Information Register and Registration Procedures, Germany, 16 April 1991

G. OSI CONFORMANCE TESTING:

ISO 9646-1.2♦ — OSI Conformance Testing Methodology and Framework - Part 1: General Model, May 1991 [SC21 N 5865] (CCITT X.290)

- PDAM 1 — Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6173] (DIS text expected March 1992; IS in December 1992)
- PDAM 2 — Multi-Party Testing Methodology, June 1991 [SC21 N 6178] (DIS text expected March 1992; IS in December 1992)

ISO 9646-2.2♦ — OSI Conformance Testing Methodology and Framework - Part 2: Abstract Test Suite Specification, May 1991 [SC21 N 5867]

- PDAM 1 — Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6174] (DIS text expected March 1992; IS in December 1992)
- PDAM 2 — Multi-Party Testing Methodology, June 1991 [SC21 N 6179] (DIS text expected March 1992; IS in December 1992)

ISO 9646-3♦ — OSI Conformance Testing Methodology and Framework - Part 3: Executable Test Derivation, July 1991

- PDAM 1 — TTCN Extensions, June 1991 [SC21 N 6180] (DIS text expected June 1992; IS in June 1993) (DIS text expected March 1992; IS in December 1992)

ISO 9646-4♦ — OSI Conformance Testing Methodology and Framework - Part 4: Test Realization (Requirements for Implementors), May 1991 [SC21 N 5869]

- PDAM 1 — Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6175] (DIS text expected March 1992; IS in December 1992)
- PDAM 2 — Multi-Party Testing Methodology, June 1991 [SC21 N 6181] (DIS text expected March 1992; IS in December 1992)

ISO 9646-5♦ — OSI Conformance Testing Methodology and Framework - Part 5: Requirements on Test Laboratories and Clients for the Conformance Assessment Process (Test Execution), May 1991 [SC21 N 5871]

- PDAM 1 — Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6176] (DIS text expected March 1992; IS in December 1992)
- PDAM 2 — Multi-Party Testing Methodology, June 1991 [SC21 N 6182] (DIS text expected March 1992; IS in December 1992)

CD 9646-6 — OSI Conformance Testing Methodology and Framework - Part 6: Protocol Profile Test Specification, June 1991 [SC21 N 6177] (DIS text expected March 1992; IS in December 1992)

WD 9646-7	OSI Conformance Testing Methodology and Framework - Part 7: Requirements and Guidelines on Implementation Conformance Statement (ICS) and ICS Proformas, June 1991 (new work item)
CD 10641	Conformance Testing of Implementations of Graphics Standards, 1991
WD xxxx	Multi-Party Testing Methodology, July 1990, SC21/WG1 [SC21 N 5076] (CD text expected October 1990)
WDTR xxxx	Catalogue of PICS Proforma Notations, July 1990 (joint work of WG1 and CCITT SG VII)
IST21 N 2531	Discussion Paper on the Nature of Protocol Profiles, UK, February 1991
IST21 N 2589	Minutes of the 20th Meeting of EWOS EGLL from October 8 to October 11, 1990, in Brussels, February 1991
SC21 N 3665	Specific Partial Abstract Test Suite (ATS) for Response Tests (CD text expected in October 1992; DIS in October 1993; IS in October 1994)
SC21 N 3666	Abstract Test Suite (ATS) for CS Test Method (WD text expected in June 1992; CD in October 1992; DIS in October 1993; IS in October 1994)
SC21 N 4215	Formal Methods in Conformance Testing (new work item, January 1990)
SC21 N 5075	Protocol Profile Testing Methodology, Second Working Draft, SC21/WG1, July 1990
SC21 N 5078	Catalogue of PICS Proforma Notations, SC21/WG1, July 1990
SC21 N 5108 ADD	Report of the Conformance Testing Meeting, held in Seoul, 22-20 May 1990, December 1990
SC21 N 5112	Discussion Paper on Formal Methods in Conformance Testing, SC21/WG1, July 1990
SC21 N 5117	Multiparty Testing for MHS, SC21/WG1, July 1990
SC21 N 5158	Conformance Test Suite for the VT Protocol, July 1990 [JTC1 N 770] (new work item; CD text expected November 1990)
SC21 N 5557	Liaison Statement to WG1 on SC6 PICS Proforma Guidelines, January 1991
SC21 N 5657	Liaison Statements from CCITT SG VII to SC21/WG1 on Various Topics (conformance testing, OSI Reference Model regarding ISDN, OSI naming and addressing), February 1991
SC21 N 5707	Position Statement on PICS Notations, SGFS, March 1991
SC21 N 5758	Discussion Paper on Conformance and Registration, UK, March 1991
SC21 N 5856	Discussion Paper on Multi-Protocol Testing, SC21/WG 1 and CCITT SG VII Collaborative Meeting on Conformance, Phoenix, 7-14 February 1991, April 1991
SC21 N 5903	Presentation Connection-Oriented Abstract Test Suite (ATS), Common Partial ATS (CD expected in June 1992; DIS in June 1993; IS in June 1994)
SC21 N 6160	Catalogue of PICS Proforma Notations, WG1, July 1991
SC21 N 6201	Working Draft on Formal Methods in Conformance Testing, WG1, July 1991
SC21 N 7016	Presentation Connection-Oriented Abstract Test Suite (ATS), Specific Partial ATS
SC21 N 7018	Common Partial Embedded ATS (CD text expected June 1992)
SGFS N 214	Catalogue of PICS Proforma Notations, SC21, January 1991
CCITT X.290	OSI Conformance Testing Methodology and Framework for Protocol Recommendations for CCITT Applications (see ISO 9646-1 and ISO 9646-2)

H. TAXONOMY AND PROFILES:

STANAG 4257♦	NATO Standard Profile on Military Message Handling System (MMHS), Draft, February 1990
STANAG xxxx♦	NATO Standard Profile on R.131(M), Draft, 1989
STANAG xxxx♦	NATO Standard Profile on TC 111(M), Draft, Version 1.3, July 1990
STANAG xxxx♦	NATO Standard Profile on TA 51(M), Draft, Version 2.0, July 1990
TR 10000-1♦	International Standardized Profiles (ISPs) - Part 1: Taxonomy Framework, July 1990 [JTC1 SGFS, SGFS N 184]
TR 10000-2♦	International Standardized Profiles (ISPs) - Part 2: Taxonomy of Profiles, July 1990 [JTC1 SGFS,SGFS N 185]
DTR 10000-2.2(E)	Framework of International Standardized Profiles (ISPs) - Part 2: Taxonomy of Profiles, June 1991 [SGFS N 384]
ISP 10607-1	ISPs - AFT nn - File Transfer, Access, and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by FTAM, April 1990 [SGFS N 131] (submitted by SPAG)
ISP 10607-2	ISPs - AFT nn - File Transfer, Access, and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes, April 1990 [SGFS N 131] (submitted by SPAG)
ISP 10607-3	ISPs - AFT nn - File Transfer, Access, and Management - Part 3: AFT 11 - Simple File Transfer Service (Unstructured), April 1990 [SGFS N 131] (submitted by SPAG)
ISP 10607-4	ISPs - AFT nn - File Transfer, Access, and Management - Part 4: AFT 12 - Positional File Transfer Service, July 1990
ISP 10607-5	ISPs - AFT nn - File Transfer, Access, and Management - Part 5: AFT 22 - Positional File Access Service, July 1990
ISP 10607-6	ISPs - AFT nn - File Transfer, Access, and Management - Part 6: AFT 12 - File Management Service, July 1990
pDISP[20] 10608-1	ISP TA - Connection-Mode Transport Service over Connectionless Network Service, Part 1: General Overview and Subnetwork-Independent Requirements
pDISP 10608-2	Part 2:TA51 Profile Including Subnetwork-Dependent Requirements for CSMA/CD LANs
pDISP 10608-5	Part 5:TA1111/TA1121 Profiles Including Subnetwork-Dependent Requirements for X.25 Packet Switched Data Networks Using Switched Virtual Circuits
DISP 10609-1	ISP Profiles TB, TC, TD, and TE - Connection-Mode Transport Service over Connection-Mode Network Service, Part 1: Subnetwork-type Independent Requirements for Group TB
DISP 10609-2	Part 2: Subnetwork-type Independent Requirements for Group TC
DISP 10609-3	Part 3: Subnetwork-type Independent Requirements for Group TD
DISP 10609-4	Part 4: Subnetwork-type Independent Requirements for Group TE
DISP 10609-5	Part 5: Definition of Profile TB 1111/TB 1121
DISP 10609-6	Part 6: Definition of Profile TC 1111/TC 1121
DISP 10609-7	Part 7: Definition of Profile TD 1111/TD 1121
DISP 10609-8	Part 8: Definition of Profile TE 1111/TE 1121

[20] pDISP: Proposed Draft International Standardization Profile.

DISP 10609-9	Part 9: Subnetwork-type Dependent Requirements for Network Layer, Data Link Layer, and Physical Layer Concerning Permanent Access to a Packet Switched Data Network Using Virtual Call
EWOS/EGTP/91/12	Draft Taxonomy for Distributed Transaction Processing, EWOS, February 1991
IST21 N 2754	Extension of M-IT-01 and M-IT-02 for the Open System Environment, European Workshop for Open Systems, EWOSTA9181, April 1991
IST21 N 2765	EWOS Proposed Taxonomy for OSI-TP, May 1991
IST21 N 2880	Interim Report on the Feasibility of Profiling Database Enquiry, EWOSPT N 014, June 1991
SGFS N 201	ISPs - Taxonomy Update, ISP Approval, and Maintenance Process, May 1990 (standing SGFS document)
SGFS N 219	An Example of T-Profiles Multi-Part ISP Structure, June 1990
SGFS N 226	Liaison Statement to JTC1 on Multi-Part ISDN ISP Structures, June 1990
SGFS N 228	Liaison Statement to JTC1 SGFS on the Inclusion of a Profile for MMS in the Taxonomy of Profiles TR 100000-2, June 1990
SGFS N 282	Resolutions of the 4th RWS-CC Meeting, 18-19 October 1990, January 1991
SGFS N 373	Output from the 5th Regional Workshop Coordinating Committee (RWS-CC), March 18-19, 1991, 13 June 1991
IST21 N 2531	Discussion Paper on the Nature of Protocol Profiles, BSI, February 1991
SC21 N 3674	ISPs - Directory of ISPs and Profiles Contained Therein, June 1989
SC21 N 3675	ISPs - ISP Approval and Maintenance Process, June 1989
SC21 N 3678	ISPs - Proposed New AMH Taxonomy, June 1989
SC21 N 4716	Initial List of Planned pDISPs, April 1990
ENV[21] 41 101♦	LANs: Provision of the OSI Connection-Mode Transport Service (COTS) Service Using the Connectionless-Mode Network Service (CLNS) on a CSMA/CD Single LAN, June 1986
ENV 41 102♦	LANs: Provision of the OSI COTS and the CLNS on a CSMA/CD Single or Multiple LAN Configuration, June 1986 (ISO Profile TA51)
ENV 41 103♦	LANs: Provision of the OSI COTS and the Connection-Mode Network Service (CONS) in an End System on a CSMA/CD LAN, December 1987
ENV 41 104	Packet Switched Data Networks: Permanent Access, August 1987 (ISO Profile Tx11y)
ENV 41 105♦	Packet Switched Data Networks: Switched Access, June 1988
ENV 41 106♦	Digital Data Circuit (CSDN) - Provision of the OSI COTS in the T.70 Case for Telematic End Systems, June 1988
ENV 41 107♦	Digital Data Circuit (CSDN) - Provision of the OSI COTS and the OSI CONS, June 1988
ENV 41 108♦	LANs: Provision of the OSI COTS and CONS in an End System on a Token Ring LAN, May 1988
ENV 41 109♦	LANs: Provision of the OSI COTS Using CLNS on a Token Ring Single LAN, February 1988
ENV 41 110♦	LANs: Provision of the OSI COTS Using CLNS in an End System on a Token Ring LAN in a Single or Multiple LAN Configuration, February 1988 (ISO Profile TA53)

[21] ENV indicates an interim standard approved by the Join European Standards Institution (CEN/CENELEC) and the European Workshop for Open Systems (EWOS).

ENV 41 201	Private Message Handling System - User Agent and Message Transfer Agent; Private Management Domain to Private Management Domain, June 1986
ENV 41 202	Message Handling Systems; User Agent and Message Transfer Agent: Access to an Administration Management Domain (ADMD), August 1987
ENV 41 203	Exchange of Telex Documents Between Two End Systems, Which May Be Teletex Terminals, June 1988
ENV 41 204♦	FTAM: Simple File Transfer, June 1988 (ISO Profile AFT11)
ENV 41 205♦	FTAM: File Management, June 1987 (ISO Profile AFT3)
ENV 41 206♦	FTAM: Positional File Transfer (ISO Profile AFT12)
ENV 41 207♦	FTAM: Positional File Access (ISO Profile AFT22)
ENV 41 208♦	VT: Basic Class - S Mode - Forms (ISO Profile AVT22)
ENV 41 209♦	VT: Control Objects
ENV 41 509♦	ODA: Basic Character Content (ISO Profile FOD11)
ENV 41 510♦	ODA: Enhanced Mixed Mode (ISO Profile FOD26)
ENV 41 511♦	ODA: Simple Messaging Profile
ENV 41 901	X.29-Mode Procedures Between a Packet Mode DTE or a PAD and a PAD via a Public or Private X.25 Packet Switched Network or ISO 8208 Packet Level Entity and ISO 7776 Link Level Entity, June 1987
M-IT-02	Directory of Functional Standards (For Interworking in an OSI Environment) Adopted by the CEN/CENELEC/CEPT/ITSTC, March 1987

II. LAYER 1: PHYSICAL LAYER[22]

A. GENERAL:

STANAG 4251♦	NATO Reference Model for OSI - Layer 1 (Physical Layer) Service Definition, Draft, July 1990
STANAG 4261♦	NATO Reference Model for OSI - Layer 1 (Physical Layer) Protocol Specification, Draft, July 1990
ISO 9160	Physical Layer Interoperability Requirements
DIS 9316	Small Computer System Interface (SCSI)
DIS 9318-1	Intelligent Peripheral Interface - Part 1: Physical Level, August 1987
ISO 9318-2	Intelligent Peripheral Interface - Part 2: Device Specific Command Set for Magnetic Disk Drives, 1990
ISO 9318-3	Intelligent Peripheral Interface - Part 3: Device Generic Command Set for Magnetic and Optical Disk Drives, 1990
ISO 9318-4	Intelligent Peripheral Interface - Part 4: Device Generic Command Set for Magnetic Tape Drives, 1990
DIS 9324	Information Processing - Storage Module Interfaces, September 1988
ISO 10022♦	Physical Service Definition, August 1990 (CCITT X.211)
DIS 10222	Enhanced Small Device Interface, 1991
CCITT X.211	Physical Service Definition for OSI for CCITT Applications (see DIS 10022), 1988 Blue Books

B. MECHANICAL:

ISO 2110.3♦	25-Pin DTE/DCE Interface Connector and Pin Assignments (Revision of ISO 2110)
	DAM 1 — Interface Connector and Contact Number Assignments for a DTE/DCE for Data Signalling Rates Above 20 kbit/s
ISO 2593.3♦	34-Pin DTE/DCE Interface Connector and Pin Assignments (third edition awaiting publication)
ISO 4902.3♦	37-Pin DTE/DCE Interface Connector & Pin Assignments, Third Edition, 1989
ISO 4903.3♦	15-Pin DTE/DCE Interface Connector and Pin Assignments, Third Edition, 1989
TR 7477♦	Arrangements for DTE/DTE Physical Connection Using V.24 and X.24 Interchange Circuits, 15 September 1985
ISO 8481♦	DTE/DTE Physical Connection Using X.24 Interchange Circuits with DTE-Provided Timing
ISO 8877♦	Interface Connector and Contact Assignments for ISDN Basic Access Interface Located at Reference Points S and T
	DAM 1♦ — Standard ISDN Basic Access TE Connecting Cord

[22] The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

DIS 10173	ISDN Primary Access Connector at Reference Points S and T
CCITT I.340	ISDN Connection Types

C. ELECTRICAL:

ISO 8482♦	Twisted Pair Multipoint Interconnections
ISO 9549♦	Galvanic Isolation of Balanced Interchange Circuits, October 1990
CCITT V.5	Data Signalling Rates for Synchronous Data Transmission in the General Switched Telephone Network
CCITT V.6	Data Signalling Rates for Synchronous Data Transmission on Leased Telephone-Type Circuits
CCITT V.28♦	Electrical Characteristics for Unbalanced Double-Current Interchange Circuits
CCITT V.31♦	Electrical Characteristics for Single-Current Interchange Circuits Controlled by Contact Closure
CCITT V.31 bis♦	Electrical Characteristics for Single-Current Interchange Circuits Using Opto Couplers
CCITT V.35♦	Data Transmission at 48 kbit/s Using 60-108 kHz Group Band Circuits
CCITT V.36♦	Modems for Synchronous Data Transmission Using 60-108 kHz Group Band Circuits

D. FUNCTIONAL:

DIS 7480.2♦	Start-Stop Transmission Signal Quality at DTE/DCE Interfaces, Draft Second Edition
ISO 9543♦	Synchronous Transmission Signal Quality at DTE/DCE Interfaces
CCITT I.411	ISDN User-Network Interfaces - Reference Configuration
CCITT I.412	ISDN User-Network Interfaces - Interface Structures and Access Capabilities
CCITT X.1	International User Classes of Service in Public Data Networks and Integrated Services Digital Networks (ISDNs)
CCITT X.4	General Structure of Signals of International Alphabet No. 5 Code for Data Transmission Over Public Data Networks
CCITT X.10	Categories of Access for DTE to Public Data Transmission Services Provided by PDNs and/or ISDNs through Terminal Adaptors
CCITT X.24♦	List of Definitions for Interchange Circuits Between DTE and DCE on Public Data Networks

E. PROCEDURAL:

ISO 8480♦	DTE/DCE Back-Up Control Operation Using the 25-Pole Connector
ISO 9067♦	Automatic Fault Isolation Procedures Using Test Loops
CCITT I.420	Basic User-Network Interface (ISDN)
CCITT I.421	Primary Rate User-Network Interface (ISDN)
CCITT I.430♦	Basic User-Network Interface - Layer 1 Specification (ISDN)
CCITT I.431♦	Primary Rate User-Network Interface - Layer 1 Specification (ISDN)
CCITT I.460♦	Multiplexing, Rate Adaptation and Support of Existing Interfaces (ISDN)
CCITT I.461♦	Support of X.21 and X.21 bis Based DTEs by an ISDN (X.30)
CCITT I.462♦	Support of Packet Mode Terminal Equipment by an ISDN (X.31)
CCITT I.463♦	Support of DTEs with V-Series Type Interfaces by an ISDN

CCITT I.464♦	Multiplexing Rate Adaptation and Support of Existing Interfaces for Restricted 64 kbit/s Transfer Capability
CCITT V.10/X.26♦	Electrical Characteristics for Unbalanced Double-Current Interchange Circuits for General Use with Integrated Circuit Equipment in the Field of Data Communication
CCITT V.11/X.27♦	Electrical Characteristics for Balanced Double-Current Interchange Circuits for General Use With Integrated Circuit Equipment in the Field of Data Communications
CCITT V.20♦	Telex and Gentex Signalling on Radio Channels (Synchronous 7-Unit Systems Affording Error Correction by Automatic Repetition)
CCITT V.24♦	List of Definitions for Interchange Circuits Between DTE and DCE
CCITT V.25	Automatic Answering Equipment and/or Parallel Automatic Calling Equipment on the General Switched Telephone Network Including Procedures for Disabling of Echo Control Devices for Both Manually and Automatically Established Calls
CCITT V.28♦	Electrical Characteristics for Unbalanced Double-Current Interchange Circuits
CCITT V.31♦	Electrical Characteristics for Single-Current Interchange Circuits Controlled by Contact Closure
CCITT V.31 bis♦	Electrical Characteristics for Single-Current Interchange Circuits Using Opto Couplers
CCITT V.35♦	Data Transmission at 48 kbit/s Using 60-108 kHz Group Band Circuits, 1988
CCITT V.36♦	Modems for Synchronous Data Transmission Using 60-108 kHz Group Band Circuits, 1988
CCITT V.37♦	Synchronous Data Transmission at a Data Signalling Rate Higher than 72 kbit/s Using 60-108 kHz Group Band Circuits
CCITT V.54	Loop Test Devices for Modems
CCITT X.20♦	Interface Between DTE and DCE for Start-Stop Transmission Services on Public Data Networks
CCITT X.20 bis	Use on Public Data Networks of DTE Which Is Designed for Interfacing to Asynchronous Duplex V-Series Modems
CCITT X.21♦	Interface Between DTE and DCE for Synchronous Operation on Public Data Networks
CCITT X.21 bis♦	Use on Public Data Networks of DTE Which Is Designed for Interfacing to Synchronous V-Series Modems
CCITT X.22♦	Multiplex DTE/DCE Interface for User Classes 3-6
CCITT X.31♦	Support of Packet Mode Terminal Equipment by an ISDN
CCITT X.32♦	Interface Between DTE and DCE for Terminals Operating in the Packet Mode and Accessing a Packet Switched PDN Through a Public Switched Telephone Network or a Circuit Switched PDN
CCITT X.150	Principles of Maintenance Testing for Public Data Networks Using DTR and DCE Test Loops

F. LOCAL AREA NETWORKS (LANs):

ISO 8802-1♦	LANs - Part 1: General Introduction
DIS 8802-1.2	LANs - Part 1: General Introduction with System Load Protocol
ISO 8802-2.2♦	LANs - Part 2: Logical Link Control, July 1990
	DAM 1♦ Flow Control Techniques for Bridged LANs
	DAM 2♦ Type 3 Operation - Acknowledge Connectionless Service

	PDAM 3	PICS Proforma
	DAM 4	Editorial Changes and Technical Corrections, June 1989
ISO 8802-3♦	LANs - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Access Method and Physical Layer Specifications	
	DAM 1♦	Physical Signalling, Medium Attachment, and Baseband Medium Specifications for Type 1BASE5
	DAM 2♦	Repeater Set and Repeater Unit Specification for Use with 10BASE5 and 10 BASE2 Networks
	DAM 3♦	Broadband Medium Attachment Unit and Broadband Medium Specifications, Type 10BROAD36
	DAM 4♦	CSMA/CD, STARLAN, 1BASE5
	DAM 5♦	Medium Attachment Baseband Medium Specification for a Vendor-Independent Fibre Optic Inter Repeater Link (FOIRL)
	DAM 6	Summary of IEEE 802.3 First Maintenance Ballot
	PDAM 7	LAN Layer Management
	PDAM 9	Physical Medium, Medium Attachment, and Baseband Medium Specifications, Type 10baseT (new work item)
ISO 8802-4.2♦	LANs - Part 4: Token-Passing Bus Access Method and Physical Layer Specifications	
ISO 8802-5♦	LANs - Part 5: Token Ring Access Method and Physical Layer Specifications, February 1987 (second DIS ballot on consolidated document--Revised Edition--containing Part 5 and its first 3 addenda closed 1 September 1990)	
	PDAM 1	4 and 16 Mbit/s Specification
	PDAM 2	MAC Sublayer Enhancement
	PDAM 3	Management Entity Specification
	DAM 4	Source Routing MAC Bridge
	DAM 5	PICS Proforma
DIS 8802-6♦	LANs - Part 6: Distributed Queue Dual Bus (DQDB) Media Access Control (MAC)	
ISO 8802-7♦	LANs - Part 7: Slotted Ring Access Method and Physical Layer Specification	
DIS 8802-9♦	LANs - Part 9: Integrated Voice and Data (IVD) LAN	
ISO 9314-1♦	Fibre Distributed Data Interface (FDDI) - Part 1: Physical Layer Protocol (PHY)	
ISO 9314-2♦	FDDI - Part 2: Media Access Control (MAC)	
ISO 9314-3♦	FDDI - Part 3: Physical Layer Medium Dependent (PMD), August 1990	
CD 9314-4	FDDI-Part 4: Single-Mode Fiber/Physical Layer Medium Dependent	
CD 9314-5	FDDI-Part 5: Hybrid Ring Control (FDDI-II), May 1990	
DP 9314-6	FDDI-Part 6: Station Management (SMT) Standard	
TR 9578	Communication Interface Connectors Used in LANs	
DIS 10038♦	MAC Sublayer Interconnection (MAC Bridging)	
	PDAM 1	Specification of Management Information for CMIP
	PDAM 2	Source Routing Supplement
ISO 10039♦	MAC Service Definition, October 1990	
PDTR 10178	Structure and Coding of Link Service Access Point Addresses in LANs	
PDTR 10734	Guidelines for Bridged LAN Source Routing Operation by End Systems	
PDTR 10735	Standard Group MAC Addresses	

III. LAYER 2: DATA LINK LAYER[23]

A. GENERAL:

STANAG 4252♦	NATO Reference Model for OSI - Layer 2 (Data Link Layer) Service Definition, Draft, July 1990
STANAG 4262♦	NATO Reference Model for OSI - Layer 2 (Data Link Layer) Protocol Specification, Draft, July 1990
ISO 8886.3[24]♦	Data Link Service Definition for OSI
TR 10171♦	List of Standard Data Link Layer Protocols that Utilize HDLC Classes of Procedures (awaiting publication)
	PDAM 1 — Registration of XID Format Identifiers and Private Parameter Set Identifiers
CCITT X.212	Data Link Service Definition for OSI for CCITT Applications (see ISO 8886), 1988 Blue Books

B. CHARACTER-ORIENTED SERVICE (BASIC MODE):

ISO 1155	Use of Longitudinal Parity to Detect Errors in Information Messages
ISO 1177	Character Structure for Start/Stop and Synchronous Character Oriented Transmission
ISO 1745	Basic Mode Control Procedures for Data Communication Systems
ISO 2111	Basic Mode Control Procedures - Code Independent Information Transfer
ISO 2628	Basic Mode Control Procedures - Complements
ISO 2629	Basic Mode Control Procedures - Conversational Information Message Transfer

C. BIT-ORIENTED SERVICE (HIGH-LEVEL DATA LINK CONTROL PROCEDURES [HDLC]):

ISO 3309♦	HDLC - Frame Structure, Third Edition (second DIS ballot for a draft fourth edition closed 26 October 1990)
	AD 1♦ — Start/Stop Transmission, March 1990
	DAM 2 — Extended Transparency Options for Start/Stop Transmission
	PDAM 3 — Seven-bit Transparency Options for Start/Stop Transmission
ISO 4335♦	HDLC - Elements of Procedures, Third Edition (second DIS ballot for a draft fourth edition closed 26 October 1990)
	AD 1♦ — Asynchronous (Start/Stop) Transmission Operation
	AD 2♦ — Enhancement of the XID Function Utility
	AD 3♦ — Start/Stop Transmission, March 1990

23 The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

24 For ISO standards, the decimal indicates the version number; thus, DIS 8886.3 is Version 3 (no decimal indicates Version 1).

	DAM 4♦	Flow Control Unnumbered Information (FUI)
	PDAD 5	Multi-Selective Reject
ISO 7478♦	Multilink Procedures	
ISO 7776♦	HDLC - Description of the X.25 LAPB-Compatible DTE Data Link Procedures	
	DAM 1	PICS Proforma
ISO 7809♦	HDLC - Consolidation of Classes of Procedures, February 1984 (second DIS ballot for a Revised Edition closed 26 October 1990)	
	AD 1♦	UI Command/Response
	AD 2♦	Descriptions of Optional Functions
	AD 3♦	Stop/Start Transmission, March 1990
	PDAD 4♦	List of Standard Data Link Layer Protocols that Utilize HDLC Classes of Procedures [see DTR 10171]
	DAM 5	Connectionless Class of Procedure
	DAM 6	Extended Transparency Option
	DAM 7	Multi-Selective Reject
	PDAM 9	Seven-bit Transparency Option for Start/Stop Transmission
ISO 8471♦	HDLC Balanced Classes of Procedures - Data Link Layer Address Resolution/ Negotiation in Switched Environments	
ISO 8885♦	HDLC - General Purpose XID Frame Information Field Content and Format	
	AD 1♦	Additional Operational Parameters for the Parameter Negotiation Data Link Layer Subfield and Definition of a Multilink Parameter Negotiation Data Link Layer Subfield
	AD 2♦	Stop/Start Transmission, March 1990
	DAM 3♦	Definition of a Private Parameter Negotiation Data Link Layer Subfield
	DAM 4	Extended Transparency Option
	DAM 5	Multi-Selective Reject
	PDAM 6	Seven-bit Transparency Option for Start/Stop Transmission
	PDAM 7	Frame Check Sequence Negotiation Using the Parameter Negotiation Subfield
DIS 9234	Industrial Asynchronous Data Link for Two-Way Simultaneous or Two-Way Alternate Mode, 1989	
CCITT T.71♦	LAPB Extended for Half-Duplex Physical Level Facility	

D. INTEGRATED SERVICES DIGITAL NETWORK (ISDN):

CCITT I.440	ISDN User-Network Interface Data Link Layer - General Aspects
CCITT I.441♦	ISDN User-Network Interface Data Link Layer - Specificatic

E. ERROR CORRECTION:

CCITT X.141	General Principles for the Detection and Correction of Errors in Public Data Networks

F. CONFORMANCE SUITE:

DIS 8882-2♦	Data Link Layer Conformance Test Suite
DTR 10174	Logical Link Control (Type 2 Operation) Test Purposes

IV. LAYER 3: NETWORK LAYER[25]

A. GENERAL:

STANAG 4253♦	NATO Reference Model for OSI - Layer 3 (Network Layer) Service Definition, Draft, July 1990
STANAG 4263♦	NATO Reference Model for OSI - Layer 3 (Network Layer) Protocol Specification, Draft, July 1990
ISO 8348♦	Network Service Definition
	AD 1♦ Connectionless-Mode Transmission
	AD 2♦ Network Layer Addressing
	AD 3♦ Additional Features of the Network Service
	PDAM 4 Removal of the Preferred Decimal Encoding of the NSAP Address
ISO 8648♦	Internal Organization of the Network Layer
	Cor.1 Technical Corrigendum 1 (awaiting publication)
ISO 8880-1♦	Protocol Combination to Provide and Support the OSI Network Service - Part 1: General Principles, 1990
ISO 8880-2♦	Protocol Combination to Provide and Support the OSI Network Service - Part 2: Provision and Support of the Connection-Mode Network Service, 1990
	DAM 1 Addition of the ISDN Environment
	PDAM 2 Addition of the PSTN and CSDN Environments
ISO 8880-3♦	Protocol Combination to Provide and Support the OSI Network Service - Part 3: Provision and Support of the Connectionless-Mode Network Service, 1990
WD 8880-4♦	Protocol Combination to Provide and Support the OSI Network Service - Part 4: Interconnection of OSI Environments
TR 9577♦	Protocol Identification in the OSI Network Layer, October 1990
TR 10172	Network/Transport Protocol Interworking Specification, October 1990
DIS 10177	Intermediate-System Support of the OSI Connection-Mode Network Service Using ISO 8208 in Accordance with ISO 10028, October 1989 (ballot closed 23 February 1991)
CD 10733	Specification of the Elements of Management Information Related to OSI Network Layer Standards [SC 21 N 5560, SC 6 6413], January 1991
CD yyyyy	Network Layer Security
CCITT T.70♦	Network-Independent Basic Transport Service for the Telematic Services
CCITT X.213	Network Service Definition for OSI for CCITT Applications

[25] The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy.*

B. PACKET-SWITCHED SERVICE:

ISO 8208♦		X.25 Packet Level Protocol (PLP) for DTE (second edition published March 1990)
	AM[26] 1.2♦	Alternative Logical Channel Number Allocation, September 1990
	PDAD 2♦	Extensions for Private Switched Use (WITHDRAWN, 1989)
	AM 3♦	Static Conformance Requirements, October 1990
ISO 8878♦		Use of X.25 to Provide the OSI Connection-Mode Network Service
	AD 1	Protection and Priority, June 1990
	AD 2	Use of an X.25 PVC to Provide the OSI CONS, June 1990
	DAM 3	Conformance
	PDAM 4	PICS Proforma
ISO 8881.3♦		Use of the X.25 PLP in LANs
ISO 8882-1♦		X.25-DTE Conformance Testing - Part 1: General Principles
DIS 8882-2♦		X.25-DTE Conformance Testing - Part 2: Data Link Conformance Test Suite
ISO 8882-3♦		X.25-DTE Conformance Testing - Part 3: Packet Level Conformance Test Suite
DIS 10588		Use of the X.25 PLP in Conjunction with X.21/X.21bis to Provide OSI CONS
CD 10732		Use of the X.25 PLP to Provide OSI CONS Over Telephone Network
CCITT X.25(84)♦		Interface Between DTE and DCE for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit
CCITT X.75(84)♦		Terminal and Transit Call Control Procedures and Data Transfer System on International Circuits Between PSDNs
CCITT X.223		Use of X.25 to Provide the OSI Connection-Mode Network Service for CCITT Applications (see ISO 8878)
CCITT X.244		Procedure for the Exchange of Protocol Identification During Virtual Call Establishment on Packet Switched Public Data Networks

C. CONNECTIONLESS SERVICE:

ISO 8473♦		Protocol for Providing the Connectionless-Mode Network Service
	PDAD 1♦	Provision of the Underlying Service Assumed by ISO 8473 Over Point-to-Point Subnetworks Which Provide the OSI Data Link Service
	PDAD 2♦	Estelle Formal Description of ISO 8473 (to be reballoted as a DTR)
	AD 3♦	Provision of the Underlying Service Assumed by ISO 8473 over Subnetworks Which Provide the OSI Data Link Service
	PDAM x	PICS Proforma (new work item)
	PDAM y	Provision of the Underlying Service Assumed by ISO 8473 over ISDN Circuit-Switched B-channels (new work item)
DIS 9068♦		Provision of the Connectionless Network Service Using ISO 8208
PDTR xxxx♦		Formal Description of ISO 8473

26 AM: Amendment to ISO standard.

. ISDN:

;O 9574♦	Provision of the OSI Connection-Mode Network Service (CONS) by Packet Mode Terminal Equipment Connected to an Integrated Services Digital Network (ISDN)
	DAM 1 — Provision of the CONS on an ISDN Circuit-Switch Channel Connecting Directly to the Remote Terminal
C21 N 5572	Report of the Ad Hoc CCIR/CCITT Experts Group Meeting on ISDN Satellite Matters 5-9 November 1990, Geneva, 7 January 1991
CITT I.450♦	ISDN User-Network Interface - Layer 3 - General Aspects
CITT I.451♦	ISDN User-Network Interface - Layer 3 - Specification
CITT I.461♦	Support of X.21 and X.21 bis Based DTEs by an ISDN (X.30)
CITT I.462♦	Support of Packet Mode Terminal Equipment by an ISDN (X.31)
CITT I.463♦	Support of DTEs with V-Series Type Interfaces by an ISDN

lote: Additional ISDN standards are listed in the last section of this Appendix

:. ROUTING AND RELAY:

SO 9542♦	End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with the Protocol for Providing the Connectionless-Mode Network Service
	Cor.[27] 1 — Technical Corrigendum 1 (awaiting publication)
	PDAM 1 — Dynamic Discovery of OSI Addresses by End Systems (new work item)
'R 9575♦	OSI Routing Framework, 1 June 1990
)IS 10028-1	Definition of the Relaying Functions of a Network Layer Intermediate System - Part 1: Connection-mode Network Service
)IS 10028-2	Definition of the Relaying Functions of a Network Layer Intermediate System - Part 2: Connectionless Network Service
'R 10029♦	Operation of an X.25 Interworking Unit, March 1989
SO 10030-1	End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP) [SC6 N 5006], October 1990
	PDAM 1 — Dynamic Discovery of OSI NSAP Addresses by End Systems (new work item)
	PDAM 3 — Specification of IS-SNARE Interactions
'D 10030-2	End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP) - Part 2: PICS Proforma [SC6 N 4053] (awaiting CD ballot)
'IS 10589	Intermediate System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8473
ST21 N 2860	EWOS Technical Guide Routeing (sic) in the Context of OSI, EWOS-EGLL9172, Final Draft, 27 May 1991
C6 N 4053	End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with ISO 8473
C6 N 5006	End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with ISO 8208 (X.25/PLP), May 1988

[7] Cor.: Technical Corrigendum to ISO standard.

SC21 N 5074	Final Answer to Q1/330.6 on Relay, Routing, and Network Management, SC21/WG1, May 1990
CCITT X.110	International Routing Principles and Routing Plan for Public Data Networks
CCITT X.353	Routing Principles for Interconnecting the Maritime Satellite Data Transmission System With Public Data Networks

F. AUTOMATIC CALLING/ANSWERING EQUIPMENT:

CCITT V.25♦	Automatic Answering Equipment and/or Parallel Automatic Calling Equipment on the General Switched Telephone Network Including Procedures for Disabling of Echo Control Devices for Both Manually and Automatically Established Calls
CCITT V.25 bis♦	Automatic Calling and/or Answering Equipment on the General Switched Telephone Network (GSTN) Using the 100-Series Interchange Circuits

G. CIRCUIT SWITCHED SERVICE:

Covered by CCITT	X.21, X.24, X.26, X.27, ISO 4903, listed under Physical Layer Standards

H. LOCAL AREA NETWORKS (LANs):

DIS 10038♦	MAC Sublayer Interconnection (MAC Bridging)
ISO 10039♦	MAC Service Definition

Other standards are covered in the discussion of LAN standards for Layer 2 (Section III)

V. LAYER 4: TRANSPORT LAYER[28]

A. GENERAL:

STANAG 4254♦	NATO Reference Model for OSI - Layer 4 (Transport Layer) Service Definition, Draft, July 1990
STANAG 4264♦	NATO Reference Model for OSI - Layer 4 (Transport Layer) Protocol Specification, Draft, July 1990
ISO 8072♦	Transport Service Definition
	AD 1♦ Connectionless-Mode Transmission
PDTR 10023♦	A Formal Description of ISO 8072 in LOTOS (awaiting decision concerning further progression)
PDTR 10172	Network/Transport Protocol Interworking Specification
CD 10736	Specification of Elements of Management Information Related to OSI Transport Layer Standards
CD xxxx♦	A Formal Description of the Transport Service Definition in Estelle
CD xxxx♦	A Formal Description of the Transport Protocol Specification in Estelle
CD xxxx♦	Transport Layer Security Protocol (awaiting CD ballot)
CCITT T.70♦	Network-Independent Basic Transport Service for the Telematic Services
CCITT X.214	Transport Service Definition for OSI for CCITT Applications

B. CONNECTION-ORIENTED SERVICE:

ISO 8073♦	Connection Oriented Transport Protocol Specification
	AD 1♦ Network Connection Management Subprotocol
	AD 2♦ Operation of Class 4 Over Connectionless Network Service
	DAM 3♦ Protocol Implementation Conformance Statement Proforma
	DAM 4 Transport Protocol Enhancements
CD 10024♦	A Formal Description of ISO 8073 in LOTOS, 1988
CCITT X.224	Transport Protocol Specification for OSI for CCITT Applications

C. CONNECTIONLESS SERVICE:

ISO 8073 DAD[29] 2♦	Connection Oriented Transport Protocol Specification - Addendum 2: Operation of Class 4 Over Connectionless Network Service
ISO 8602♦	Protocol for Providing the Connectionless-Mode Transport Service
	DAM 1 PICS Proforma

28 The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

29 DAD: Draft Addendum for an ISO Standard (has the status of a DIS).

D. CONFORMANCE TESTING:

DIS 10025-1♦	Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 1: General Principles, 1989
CD 10025-2♦	Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 2: Test Suite Structure and Test Principles, 1989
DP 10025-3♦	Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 3: Abstract Test Suite Specification, 1989
DIS 10739-1	Conformance Test Suite for 9041 - Virtual Terminal Basic Class Protocol - Part 1: Test Suite Structure and Test Purposes [SC21 N 5158, January 1991] (IS expected July 1992)
CD xxxxx	Transport Test Management Protocol

VI. LAYER 5: SESSION LAYER[30]

A. GENERAL:

STANAG 4255♦	NATO Reference Model for OSI - Layer 5 (Session Layer) Service Definition, Draft, April 1990
STANAG 4265♦	NATO Reference Model for OSI - Layer 5 (Session Layer) Protocol Specification, Draft, April 1990
ISO 8326♦	Basic Connection-Oriented Session Service Definition (equivalent to CCITT X.215), August 1987 (draft revised text of April 1990 incorporates AD 1, AD 2, and AD 3); Technical Corrigendum, April 1990
AD 1♦	Session Symmetric Synchronization for the Session Service (not part of CCITT Recommendation), October 1989 [SC21 N 3507]
AD 2♦	Incorporation of Unlimited User Data, June 1988 [SC21 N 2495]
AD 3♦	Connectionless-Mode Session Service, August 1989 [SC21 N 3462]
DAM 4.2	Additional Resynchronization Functionality, May 1991 [SC21 N 5921]
TR 9571♦	LOTOS Description of the Session Service, September 1989 [SC21 N 3148, January 1989]
TR 9572♦	LOTOS Description of the Session Protocol, September 1989 [SC21 N 3149, January 1989]
DIS 10168-1♦	Conformance Test Suite for the Session Protocol - Part 1: Test Suite Structure and Test Purposes, 19 April 1990 [SC21 N 4159, December 1989] (IS status expected in late 1991)
WD 10168-2♦	Conformance Test Suite for the Session Protocol - Part 2: Generic Test Suite, 1989 (CD text expected October 1993, DIS in October 1994, IS in October 1995)
WD 10168-3♦	Conformance Test Suite for the Session Protocol - Part 3: Abstract Test Suite for CS Method, 1989 (CD text expected in late 1991, DIS in June 1992, IS in June 1993)
DIS 10168-4♦	Conformance Test Suite for the Session Protocol - Part 4: Session Test Management Protocol Specification, December 1990 [SC21 N 5026]
SC21 N 6110	Session Layer Extension to Support Re-Use of Transport Connections, WG6, JTC1 N 1436, 3 July 1991 (voting ends 21 October 1991) (new work item)
CCITT X.215	Session Service Definition for OSI for CCITT Applications

30 The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy.*

B. CONNECTION-ORIENTED SERVICE:

ISO 8327♦	Basic Connection-Oriented Session Protocol Specification, August 1987 (draft revised text of April 1990 incorporates AD 1 and AD 2); Technical Corrigendum, April 1990
	AD 1♦ Session Symmetric Synchronization for the Session Protocol, October 1989 [SC21 N 3508]
	AD 2♦ Incorporation of Unlimited User Data, June 1988 [SC21 N 2494]
	PDAM 3.2 Additional Synchronization Functionality, May 1991 [SC21 N 5922]
CD 8327-2.2♦	Basic Connection-Oriented Session Protocol Specification - Part 2: PICS Proforma, July 1990 [SC21 N 5022] (second draft)
CCITT X.225	Session Protocol Specification for OSI for CCITT Application

C. CONNECTIONLESS SERVICE:

ISO 8326 AD 3♦	Basic Connection-Oriented Session Service Definition, Connectionless-Mode Session Service, August 1989 [SC21 N 3462]
ISO 9548♦	Session Connectionless Protocol to Provide Connectionless-Mode Session Service [SC21 N 3460], August 1989
CD 9548-2.2	Session Connectionless Protocol to Provide Connectionless-Mode Session Service - Part 2: PICS Proforma, May 1991 (second CD ballot closes 13 September 1991; DIS status expected December 1991; IS expected December 1992)

D. TELEMATIC SERVICES:

CCITT T.5♦	General Aspects of Group 4 Facsimile Apparatus
CCITT T.62♦	Control Procedures for Teletex and Group 4 Facsimile Services
CCITT X.3♦	Packet Assembly/Disassembly Facility (PAD) in a Public Data Network (PDN), 1988
CCITT X.20♦	Interface Between DTE and DCE for Start-Stop Transmission Services on Public Data Networks, 1988
CCITT X.28♦	DTE/DCE Interface for a Start/Stop Mode DTE Accessing the PAD in a PDN Situated in the Same Directory (Country), 1988
CCITT X.29♦	Procedures for the Exchange of Control Information and User Data Between a PAD and a Packet Mode DTE or Another PAD, 1988

VII. LAYER 6: PRESENTATION LAYER[31]

A. GENERAL:

STANAG 4256♦	Presentation Layer Service Definition, Draft, January 1990
STANAG 4266♦	Presentation Layer Protocol Specification, Draft, January 1990
ISO 8822♦	Connection-Oriented Presentation Service Definition, August 1988
AD 1♦	Connectionless-Mode Presentation Service, July 1990 [SC21 N 4933]
PDAM 2♦	Support of Session Symmetric Synchronization Service, February 1990 (DIS text expected in December 1991, IS text in December 1992)
PDAM 3.2	Unlimited User Data, July 1991 [SC21 N 5065, July 1990] (DIS text expected June 1992, IS text in June 1993)
PDAM 4	Abstract Syntax Registration, July 1990 [SC21 N 5067] (DIS text expected in 1991, IS text in March 1992)
PDAM 5	Delivery of additional session synchronizaton functionality to the presentation service user, October 1990 [SC21 N 5411] (DIS text expected in 1991, IS text in March 1992)
WDAM 6	Confidentiality and Integrity, July 1990 [SC21 N 5054] (PDAM text expected December 1991, DIS in June 1992, IS in June 1993)
ISO 8823♦	Connection-Oriented Presentation Protocol Specification
DAD 1	Renumbered as DIS 8823-2 (see below)
WDAM 2♦	Support of Session Symmetric Synchronization Service, February 1990
PDAM 3	Transfer Syntax Registration, July 1990 [SC21 N 5068] (DIS text expected August 1991, IS text in June 1992)
PDAM 4	Unlimited User Data, July 1990 [SC21 N 5066]
PDAM 5	Additional Resynchronization Functionality, October 1990 [SC21 N 5412] (DIS text expected in 1991, IS text in March 1992)
WDAM 6	Confidentiality and Integrity, July 1990 [SC21 N 5064, July 1990]
DIS 8823-2	Connection-Oriented Presentation Protocol Specification - Part 2: PICS Proforma, July 1990 [SC21 N 5258] (IS text expected November 1992)
DIS 10729-1♦	Conformance Test Suite for the Presentation Protocol, Part 1: Test Suite Structure and Test Purposes, SC21/WG6, 27 June 1991 [SC21 N 5019, August 1990] (IS expected June 1992)
WD 10729-2♦	Conformance Test Suite for the Presentation Protocol, Part 2: Test Suite Structure and Test Purposes for ASN.1 Encodings, SC21/WG6, February 1990

[31] The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy.*

	[SC21 N 4151] (CD text expected in October 1991, DIS in June 1992, IS in June 1993)
SC21 N 5054	Working Document on Basic Connection-Oriented Presentation Service Definition - Presentation Service to Give Confidentiality and Integrity Protection, SC21/WG6, July 1990
SC21 N 5064	Working Document on Basic Connection-Oriented Presentation Protocol Specification - Amendment to the Presentation Protocol to Give Confidentiality and Integrity Protection, SC21/WG6, 11 July 1990
CCITT X.216	Presentation Service Definition for OSI for CCITT Applications (see ISO 8822, 1988)
CCITT X.226	Presentation Protocol Specification for OSI for CCITT Application (see ISO 8823, 1988)

B. CONNECTIONLESS SERVICE:

ISO 8822 AD 1♦	Connection-Oriented Presentation Service Definition - Connectionless-Mode Presentation Service, July 1990 [SC21 N 4933]
ISO 9576-1♦	Presentation Connectionless Protocol to Provide Connectionless-Mode Presentation Service, July 1990 [SC21 N 4934]
DIS 9576–2	Presentation Connectionless Protocol to Provide Connectionless-Mode Presentation Service - Part 2: PICS Proforma, July 1990 [SC21 N 5020] (balloting ended 4 January 1991; IS expected February 1992)

C. ABSTRACT SYNTAX NOTATION ONE (ASN.1):

STANAG 4258♦	Specification of ASN.1, Draft, January 1990	
STANAG 4259♦	Specification of Basic Encoding Rules for ASN.1, Draft, January 1990	
ISO 8824♦	Specification of ASN.1, December 1987; Revised text of April 1990 incorporates AM 1 on ASN.1 Extensions [SC21 N 4720]	
	AD 1♦	ASN.1 Extensions, June 1988 (incorporated in Revised Edition of ISO 8824)
	PDAM 2	Amendments to ISO 8824 to Give ISO 8824 Part 1: Basic ASN.1, July 1991 [SC21 N 6294] (balloting ends 29 October 1991; DIS text expected December 1991, IS in October 1992)
WD 8824-1	Specification of Abstract Syntax Notation One (ASN.1) - Part 1: Basic ASN.1, July 1991 [SC21 N 6294]	
CD 8824-2	Specification of Abstract Syntax Notation One (ASN.1) - Part 2: Information Object Specification, July 1991 [SC21 N 6289]	
CD 8824-3	Specification of Abstract Syntax Notation One (ASN.1) - Part 3: Constraint Specification, July 1991 [SC21 N 6290]	
CD 8824-4	Specification of Abstract Syntax Notation One (ASN.1) - Part 3: Parameterisation of ASN.1 Specifications, July 1991 [SC21 N 6291]	
ISO 8825♦	Specification of Basic Encoding Rules for ASN.1, November 1987 [SC21 N 4721] (revised text of April 1990 incorporates AM 1 on ASN.1 Extensions)	
	AD 1♦	ASN.1 Extensions, June 1988 (incorporated in Revised Edition of ISO 8825)
	WDAM 2	Amendments to ISO 8825 to Give ISO 8825 Part 1: Basic Encoding Rules, July 1991 [SC21 N 6295] (balloting ends

	29 October 1991; DIS text expected December 1991, IS in October 1992)
WD 8825-1	Specification of Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 1: Basic Encoding Rules, July 1991 [SC21 N 6295]
CD 8825-2	Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 2: Packed Encoding Rules, July 1991 [SC21 N 6292]
CD 8825-3	Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 3: Distinguished Encoding Rules, July 1991 [SC21 N 6293]
WD 8825-4	Conformance Test Suite for the Presentation Protocol - Part 2: Test Suite Structure and Test Purposes for ASN.1 Encodings, SC21/WG6, July 1990 [SC21 N 5019]
SC21 N 3174	Working Document on ASN.1, Including Timetable, March 1989 [SC21/WG6]
SC21 N 5051	Working Document on ASN.1 Extensions, Character Sets, Version 3, SC21/WG6, July 1990
SC21 N 5052	Working Document on ASN.1 Extensions, Table Types and Functions, Version 4, SC21/WG6, July 1990
SC21 N 5053	Working Document on ASN.1 Extensions, Machine Processibility, Version 3, SC21/WG6, May 1990
SC21 N 5055	Working Document on ASN.1 Extensions, Miscellaneous Enhancements, Version 3, SC21/WG6, May 1990
SC21 N 5061	Handling of Exception Cases in ASN.1, SC21/WG6, July 1990
SC21 N 5063	Liaison on Handling of Character Sets in ASN.1, JTC1/SC2, June 1990
SC21 N 5069	Call for Comments on Technical Approval for Development of ASN.1 Work Plan, SC21/WG6, July 1990
SC21 N 6130	Working Draft for ASN.1 Encoding Rules to Provide Upper Layer Security and Compression, WG6, June 1991
SC21 N 6131	Working Draft on Light-Weight encoding Rules for ASN.1, WG6, July 1991
SC21 N 6133	Abstract Syntax Model, WG6, June 1991
SC21 N 6136	Light Weight Encoding Rules (LWER) for ASN.1, WG6, JTC1 N 1434, July 1991 (voting ends 21 October 1991) (draft is SC21 N 6131) (new work item)
CCITT X.208	Specification of Abstract Syntax Notation One (ASN.1) (see ISO 8824, Revised Edition)
CCITT X.209	Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) (see ISO 8825, Revised Edition)

D. TELEMATIC SERVICES:

CCITT T.6♦	Facsimile (FAX) coding schemes and coding control functions for Group 4 Facsimile Apparatus
CCITT T.51♦	Coded Character Sets for Telematic Services
CCITT T.61♦	Character Repertoire and Coded Character Sets for the International Teletex Service
CCITT T.73♦	Document Interchange Protocol for the Telematic Services

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VIII. LAYER 7: APPLICATION LAYER[32]

A. GENERAL:

STANAGs♦	[Separate Application Layer STANAGs will be developed for each application; each will contain the service definition, the protocol specification, and an interoperability profile.][33]
ISO 9545♦	Application Layer Structure (ALS), December 1989 [SC21 N 3825, August 1989]
	PDAM 1 — Extended Application Layer Structure (XALS), July 1990 [SC21 N 5012] , April 1991
	WDAM 2 — Connectionless Mode Transmission, June 1988 [SC21 N 2470] (PDAM expected late 1991)
CD 10745	Upper Layer Security Model, June 1991 [SC21 N 6095] (CD ballot closes 22 October 1991)
WD xxxx	Service and Protocol for Authentication Exchange Application Service Element (ASE), January 1990 [SC21 N 4110]
PDTR xxxx	Methodology and Guidelines for the Development of Application Layer Protocols, June 1990 [SC21 N 4903] (new work item of June 1988 failed but program of work with CDTR is still active; status uncertain)
WDTR xxxx	Application Layer Guidelines, November 1989 [SC21 N 3206, December 1988]
SC21 N 3109	Architectural and Descriptive Issues Identified During the Workshop on Application Layer Standardization, December 1988 [SC21/WG1]
SC21 N 3208	Requirements for More Efficient Use of Application Associations, December 1988 [SC21/WG6]
SC21 N 3733	Access Control for OSI Applications, July 1989
SC21 N 4002	Extended Application Layer Structure, ANSI Contribution to SC21/WG6, October 1989
SC21 N 4106	Application Layer Recovery, January 1990 (new work item)
SC21 N 4107	Modelling for Communications Aspects of Distributed Applications, January 1990 (new work item)
SC21 N 4108	Management Information in the Upper Layers, January 1990
SC21 N 4110	Service and Protocol for Security Application Service Element, Proposal for NWI, January 1990 [name changed from Authentication Exchange ASE to Security ASE; CD expected June 1992]
SC21 N 4354	Topics Proposed for Discussion at the JTC1 Workshop on Distributed Applications, Phoenix, March 1990, U.K. Contribution, January 1990
SC21 N 4519	Clarification of ALS Modelling Concepts, Workshop on Distributed Applications, April 1990
SC21 N 4520	Issues for Consideration by Joint ULA/ODP Meeting, Seoul, May/June 1990, Workshop on Distributed Applications, April 1990

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32 The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

33 *NTIS Transition Strategy*, p.3.

SC21 N 4674	Liaison Statement Regarding Common Application Interfaces for the Telematic Services, CCITT SG I, May 1990
SC21 N 4764	Progression of Association Pools, ANSI, May 1990
SC21 N 4766	U.S. Response to SC21/WG6 N 770 on Requirements for Extended ALS, ANSI, May 1990
SC21 N 4903	Methodology and Guidelines for the Development of Application Layer Standards, SC21/WG6, June 1990
SC21 N 4904	Request for Comment on Characteristics of an Application Service Element and Application Service Object, SC21/WG6, May 1990
SC21 N 4905	Request for Comment on Introduction of a New Relationship in ALS, SC21/WG6, June 1990
SC21 N 4908	Liaison to CCITT SG VII(Q19,Q25) on ULA Topics, SC21/WG6, June 1990
SC21 N 4926	Liaison to CCITT SG VII(Q19) on DAF, SC21/WG6, June 1990
SC21 N 5003	Distributed Applications Security Modelling and Infrastructure, SC21/WG6, July 1991
SC21 N 5011	Modelling Recovery in the Application Layer, SC21/WG6, 1 June 1990 (new work item)
SC21 N 5012	Mock-up of ISO/IEC 9545 ALS with Proposed Changes for Extended ALS, November 1990
SC21 N 5012	Proposed Draft Amendment 1 to ALS on Extended Application Layer Structure, ISO/IEC JTC WG6 ULA, November 1990
SC21 N 5016	Meeting Report for SC21/WG1/WG4/WG6/WG7 Joint Meeting on Service Conventions, ODP, and ULA on 29 May 1990, SC21, June 1990
SC21 N 5502	Liaison Concerning Application Context Negotiation During Association Establishment, November 1990
SC21 N 5503	Response to Liaison Statement SC21 N 5453 on ULA Issues Arising on Security Work, November 1990
SC21 N 5504	Response to Liaison Statement to WG6 ULA and Upper Layer Security Groups (SC21/WG6 N 906), November 1990
SC21 N 6017	Comments on Standardization of Application Programmatic (sic) Interfaces, WG4, May 1991
SC21 N 6061	Progression of Methodology and Guidelines for the Development of Application Layer Standards, WG6, June 1991
SC21 N 6068	Modelling Recovery in the Application Layer, WG6, June 1991
SC21 N 6071	Guidelines for Application Context Definition, WG6, June 1991
SC21 N 6096	Working Draft of Security Exchange ASE - Part 1: Security Exchange Model and Specification Framework, WG6, June 1991 [Part 2: Security Exchange ASE Service Definition; Part 3: Security Exchange ASE Protocol Specification; and Part 4: Security Exchange ASE PICS Proforma]
SC21 N 6097	Working Draft of Security Exchange ASE - Part 2: Security Exchange ASE Service Definition, WG6, June 1991
SC21 N 6098	Working Draft of Security Exchange ASE - Part 3: Security Exchange ASE Protocol Specification, WG6, June 1991
SC21 N 6099	Authentication Services for Distributed Applications, WG6, 1 July 1991 [WD 5/91, CD 5/92, DIS 5/93, IS 5/94], JTC1 N 1437, July 1991 (new work item)

Note: Presentation cryptographic techniques [Project transferred from SC20]

Note: Practical conditions for ACSE authentication [Project transferred from SC20]

B. OSI DIRECTORY:

ISO 9594-1♦ The Directory - Part 1: Overview of Concepts, Models and Services, July 1990 [SC21 N 4701] (CCITT X.500)

PDAM 1.2 Replication, Schema and Access Control, May 1991 [SC21 N 5942] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-2♦ The Directory - Part 2: Models, July 1990 [SC21 N 4702] (CCITT X.501)

PDAM 1.3 Access Control, May 1991 [SC21 N 5952] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

PDAM 2.2 Schema Extensions, May 1991 [SC21 N 5943] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

PDAM 3.2 Replication, May 1991 [SC21 N 5944] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-3♦ The Directory - Part 3: Abstract Service Definition, July 1990 [SC21 N 4703] (CCITT X.511)

PDAM 1.3 Access Control, May 1991 [SC21 N 5953] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

PDAM 2.2 Replication, Schema and Enhanced Search, May 1991 [SC21 N 5945] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-4♦ The Directory - Part 4: Procedures for Distributed Operations, July 1990 [SC21 N 4704] (CCITT X.518)

PDAM 1.2 Access Control, May 1991 [SC21 N 5954] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

PDAM 2.2 Replication, Schema and Enhanced Search, May 1991 [SC21 N 5946] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-5♦ The Directory - Part 5: Protocol Specifications, July 1990 [SC21 N 4705] (CCITT X.519)

PDAM 1.2 Replication, May 1991 [SC21 N 5947] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-6♦ The Directory - Part 6: Selected Attribute Types, July 1990 [SC21 N 4706] (CCITT X.520)

PDAM 1.2 Schema Extensions, May 1991 [SC21 N 5946] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-7♦ The Directory - Part 7: Selected Object Classes, July 1990 [SC21 N 4707] (CCITT X.521)

PDAM 1.2 Schema Extensions, May 1991 [SC21 N 5946] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)

ISO 9594-8♦	The Directory - Part 8: Authentication Framework, July 1990 [SC21 N 4708] (CCITT X.509)
	PDAM 1.2 — Access Control, May 1991 [SC21 N 5955] (balloting ends September 1991; DIS text expected in November 1991, IS in October 1992)
CD 9594-9.2	The Directory - Part 9: Replication, May 1991 [SC21 N 5951]
WD 9594-10♦	The Directory - Part 10: Directory PICS Proforma, July 1990 [SC21 N 4913] (CD text expected in June 1992, DIS text in June 1993, and IS text in June 1994)
WD 9594-X♦	The Directory - Part X: Text Suite Structure and Test Purposes and Abstract Test Suite for the OSI Directory, August 1990 [SC21 N 4951] (NWI not accepted]
WD 9594-Y♦	The Directory - Part Y: Replication and Knowledge Management, July 1990 [SC21 N 4913] (CD text expected November 1991]
SC21 N 3316	Access Control for OSI Management and The Directory
SC21 N 3317	Working Document on Extended Information Models
SC21 N 3318	Working Document on the Directory Schema
SC21 N 3319	Working Document on Replication and Knowledge Distribution
SC21 N 3320	Working Document on Access Control
SC21 N 3321	Working Document on Enhanced Search
SC21 N 3322	Working Document on Attribute Classes
SC21 N 3323	Request for National Body and CCITT Member Contributions on Directory PICS Proforma
SC21 N 4709	Directory Implementor's Guide, CCITT WG VII(Q.20), June 1990
SC21 N 4744	Development of the DSA Information Model: Extended Distribution Knowledge Model, SC21/WG4, May 1990
SC21 N 4769	Discussion of Initial Schema Information Acquisition for Directory, SC21/WG4, May 1990
SC21 N 4770	Short-Form Names for Directory, SC21/WG4, May 1990
SC21 N 4771	US Positions on SC21 N 433, Working Draft on the Schema, SC21/WG4, May 1990
SC21 N 4773	Development of the DSA Information Model: Basic Distribution Knowledge, SC21/WG4, May 1990
SC21 N 4799	Letter for Information on Disposition of EDIMS Use of Directory, May 1990
SC21 N 4802	Liaison Statement to SC21 on Comments on Short Form Names and Other Name Forms, CCITT SG I(Q.16), May 1990
SC21 N 4803	Publication of Directory Schema and Other Registered Object Definitions, Canada, May 1990
SC21 N 4804	Proposed DIT Structure Rule Definition, May 1990
SC21 N 4806	Use of External Data Transfer Systems for Shadow Updates, May 1990
SC21 N 4918	Question on Standardization of Directory API, July 1990
SC21 N 4922	Information on Distributed Entries, SC21/WG4, July 1990
SC21 N 4924	Extensions to Directory Abstract Service, Working Draft, SC21/WG4, July 1990
SC21 N 4951	Test Suites for OSI Directory, SC21/WG4, July 1990 (new work item)
SC21 N 5351	USA, Time Stamps, September 1990

SC21 N 5426	Directory Implementor's Guide - Editor, Version 3, ISO/IEC JTC1, November 1990
SC21 N 5826	EWOS Working Document on Behaviour of DSAs for Distributed Operations, EWOS/EGDIR/91/A/713, April 1991
SC21 N 6002	Liaison to SC21 on Directory's Use of ISO 9066 (ROSE), WG4, June 1991
SC21 N 6006	Use of Systems Management for Administration of the Directory, WG4, JTC1 N 1440, July 1991 (new work item)
SC21 N 6007	FTAM Document Type for Directory, WG4, May 1991
SC21 N 6063	Use of Object Identifiers to Access Directory Information, WG6, June 1991
SC21 N 6172	Security Enhancement to Directory (Extension to ISO/IEC 9594-8), WG1, July 1991 (new work item)
CCITT X.500	The Directory - Overview of Concepts, Models, and Services
CCITT X.501	The Directory - Models
CCITT X.509	The Directory - Authentication Framework
CCITT X.511	The Directory - Abstract Service Definition
CCITT X.518	The Directory - Procedures for Distributed Operation
CCITT X.519	The Directory - Protocol Specifications
CCITT X.520	The Directory - Selected Attribute Types
CCITT X.521	The Directory - Selected Object Classes

C. OPERATING SYSTEM INTERFACE:

ISO 2375	Data Processing - Procedures for the Registration of Escape Sequences, November 1985
ISO 9945-1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1: System Interface, 1990
DP 9945-1.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.1: Language Independent Base (WG 15 work item based on IEEE P1003.1c)
DP 9945-1.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.2: Realtime and Extensions (WG 15 work item based on IEEE P1003.4 and .1b)
DP 9945-1.3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3: Distribution Services (WG 15 work item based on IEEE P1003.8)
DP 9945-1.3.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.1: Transparent File Access (WG 15 work item based on IEEE P1003.8)
DP 9945-1.3.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.2: Remote Procedure Call (WG 15 work item based on IEEE P1237)
DP 9945-1.3.3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.3: Transport Interface (WG 15 work item based on IEEE P1003.11)
DP 9945-1.3.4,	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.4: Name Space/Directory Services (WG 15 work item based on IEEE P1003.12)
DP 9945-2	Portable Operating System Interface for Computer Environments (POSIX) - Part 2: Shell and Utilities, 1990 [failed registration ballot; new draft requested for registration (on hold)]

DP 9945-2.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 2.1: Shell and Utilities (WG 15 work item based on IEEE P1003.2)
DP 9945-2.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 2.2: User Portability Extensions (WG 15 work item based on IEEE P1003.2a)
DP 9945-3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1: System Management
DP 9945-3.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 3.1: General Services (WG 15 work item based on IEEE P1003.7)
DP 9934-3.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 3.2: Batch Services (WG 15 work item based on IEEE P1003.10)
DP xxxx♦	Operating System Command and Response Language (OSCRL)
DP xxxx♦	System Software Interface for Application Programmes (SSI)
IST21 N 2852	POSIX Security Call for New Work Items, SC22/WG15, June 1991

D. ASSOCIATION CONTROL SERVICE ELEMENT (ACSE):

ISO 8649♦	Service Definition for the ACSE (equivalent to CCITT X.217)	
	AM 1	Peer-Entity Authentication During Association Establishment, September 1989 [SC21 N 5462, November 1990]
	AM 2♦	Connectionless-Mode ACSE Service, April 1989 [SC21 N 3458]
	WDAD 3♦	Application Context Management (CD text expected October 1991)
ISO 8650♦	Protocol Specification for the ACSE (equivalent to CCITT X.227); Technical Corrigendum, 1 June 1990	
	AM 1	Peer-Entity Authentication During Association Establishment, September 1989 [SC21 N 5463, November 1990]
	WDAM 3♦	Application Context Management (CD expected October 1991)
	WDAD 4	Application Entity Titles
DIS 8650-2	ACSE PICS Proforma, July 1990 [SC21 N 5024] (IS text expected in 1991)	
ISO 10035♦	Connectionless ACSE Protocol Specification, July 1990 [SC21 N 3456]	
WD 10035-2	Connectionless ACSE Protocol Specification - Part 2: PICS Proforma for Connectionless ACSE Protocol, July 1989 [SC21 N 3218]	
DIS 10169-1.2♦	Conformance Test Suite for the ACSE Protocol - Part 1: Test Suite Structure and Test Purposes, February 1989 [SC21 N 3219] (ballot closed 19 October 1990; editing meeting January 1991; proposed progression to IS not defined)	
SC21 N 5835	Discussion Paper on Association Pools as an Extension of ACSE, WG5, April 1991	
CCITT X.217	Association Control Service Definition for OSI for CCITT Applications (see ISO 8649)	
CCITT X.227	Association Control Protocol Specification for OSI for CCITT Applications (see ISO 8650)	

E. COMMITMENT, CONCURRENCY, AND RECOVERY (CCR) SERVICE ELEMENT:

ISO 9804♦ — Service Definition for the Commitment, Concurrency, and Recovery (CCR) Service Element Service, July 1990 [SC21 N 4611] (CCITT X.237)

- PDAM 1♦ — Enhancements, October 1990 [SC21 N 5122] (DIS text expected June 1993, IS text in June 1994)
- PDAM 2♦ — Session Mapping Changes (Additional Resynchronization Functionality), October 1990 [SC21 N 5343] (DIS text expected in 1991, IS in March 1992)
- WDAM 3♦ — Restart (CD text expected May 1992)

ISO 9805♦ — Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Service Element Protocol, April 1990 [SC21 N 4612] (CCITT X.247)

- PDAM 1♦ — Enhancements, June 1990 [SC21 N 5120] (DIS text expected March 1993, IS text March 1994)
- PDAM 2♦ — Session Mapping Changes (Additional Resynchronization Functionality), October 1990 [SC21 N 5123] (DIS text expected in 1991, IS in March 1992)
- WDAM 3♦ — Restart (CD text expected May 1992, DIS in May 1993, IS in May 1994)

CD 9805-2♦ — Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Service Element Protocol - Part 2: PICS Proforma, March 1991 [SC21 N 5797] (DIS text expected November 1991, IS text November 1992)

SC21 N 3180 — Possible CCR Extensions - Base Text, January 1989 [SC21/WG6]

SC21 N 4279 — CCR Conformance Test Suite, January 1990 (CD text expected June 1993)

SC21 N 5833 — TP/CCR Extensions - Proposed Restructure for Future Work, USA, April 1991

SC21 N 6126 — LOTOS Description of CCR Service and Protocol, WG6, JTC1 N 1435, 3 July 1991 (voting ends 21 October 1991) [PDTR 5/92, DTR 6/93, TR 6/94] (new work item)

F. RELIABLE TRANSFER (RT), REMOTE OPERATIONS (RO), AND REMOTE PROCEDURE CALL (RPC):

ISO 9066-1.2♦ — Reliable Transfer - Part 1: Model, Notation and Service Definition

ISO 9066-2.2♦ — Reliable Transfer - Part 2: Protocol Specification

ISO 9072-1.2♦ — Remote Operations - Part 1: Concepts and Model

ISO 9072-2.2♦ — Remote Operations - Part 1: Protocol Specification

DIS 10148 — Basic Remote Procedure Call (RPC) Using OSI Remote Operations, [SC21 N 3463; fast-track ballot failed; DIS 10148 WITHDRAWN; proposal for new work item, SC21 N 4153, January 1990] (CD text for RPC model, service, and protocol now planned for June 1991)

SC21 N 4523 — Modelling of Application Program Interfaces and Remote Procedure Calls, Distributed Applications Workshop, 2 April 1990

SC21 N 4767 — US Response to SC21/WG6 N 7889 on Requirements for RPC Interface Definition Notation, May 1990

SC21 N 4925 — Liaison to SC22/WG11 Concerning Remote Procedure Call Interface Definition Notation (IDN), June 1990

SC21 N 4927 — Remote Procedure Call, Working Draft, SC21/WG6, June 1990

SC21 N 4928 — Remote Procedure Call Definitions and Requirements, SC21/WG6, June 1990

SC21 N 5583	RPC Rapporteur Group Meeting, Valbonne, 5-9 November 1990
SC21 N 5584	Remote Procedure Call, Second Working Draft, SC21/WG6, January 1991
SC21 N 5585	Call for Comment on RPC Bindings in the Computational Model, SC21/WG6, January 1991
SC21 N 5586	Call for Comment on the Nature of the OSI RPC Service Boundary and Service Provider, SC21/WG6, January 1991
SC21 N 5587	Call for Comment on RPC Exception Model, SC21/WG6, January 1991
SC21 N 5588	Call for Comment on OSI RPC Interface Definition Notation (IDN), SC21/WG6, January 1991
SC21 N 5590	Temporary Working Definitions for (RPC) Client and Server, SC21/WG6, January 1991
SC21 N 5593	The Role of the Extended Application Layer Structure in the Standardization of RPC, ECMA, January 1991
SC21 N 5596	Multiple Outstanding RPC Calls, ECMA, January 1991
SC21 N 5597	RPC Context Handles, ECMA, January 1991
SC21 N 5816	Position on RPC Modelling, ECMA, March 1991
SC21 N 5817	Binding Concepts Within RPC, ECMA, March 1991
SC21 N 5818	Proposal for RPC Service Definition and Protocol Specification Parts, ECMA, March 1991
SC21 N 5819	Modelling Rationale for OSI RPC, ECMA, 28 March 1991
SC21 N 5821	Contribution on the [RPC] Computation Model, ECMA, 28 March 1991
SC21 N 5822	Proposal for the Use of the XALS in the Standardization of RPC, ECMA, March 1991
SC21 N 5997	USA Position on Use of RTSE by SC21 Standards, June 1991
SC21 N 6002	Liaison to SC21 on Directory's Use of ISO 9066 (ROSE), WG4, June 1991
SC21 N 6111	Information Technology - Open Systems Interconnection - Remote Procedure Call, Third Working Draft, WG6, June 1991
SC21 N 6119	RO Extensions--Concepts, Model, and Notation, WG6, June 1991
SC21 N 6120	RO Extensions--Service Definition, WG6, June 1991
SC21 N 6121	RO Extensions--Protocol Specification, WG6, June 1991
SC21 N 6151	Enhancements to ROSE Service Definition, Protocol Specification, and Concepts, Model and Notation, WG6, July 1991; JTC1 N 1433 (new work item)
CCITT X.218	Reliable Transfer: Model and Service Definition (see ISO 9066-1)
CCITT X.219	Remote Operations: Model, Notation and Service Definition (see ISO 9072-1)

G. MESSAGE HANDLING SYSTEM (MHS):

STANAG 4257♦	Military Message Handling System (MMHS), Draft, May 1990
IST21 N 2685	Access to Public and Private MHS (1988) Common Facilities MTS End-User to MTS End-User and MTA, March 1991
CCITT X.218	Reliable Transfer: Model and Service Definition (see ISO 9066-1)
CCITT X.219	Remote Operations: Model and Service Definition (see ISO 9072-1)
CCITT X.228	Reliable Transfer: Protocol Specification (see ISO 9066-2)
CCITT X.229	Remote Operations: Protocol Specification (see ISO 9072-2)

CCITT X.400♦	Message Handling Systems (MHSs): System Model - Service Elements (see ISO 10021-1 for MOTIS)
CCITT X.401♦	MHSs - Basic Service Elements and Optional User Facilities
CCITT X.402♦	MHSs: Overall Architecture (ISO 10021-2, MOTIS)
CCITT X.403♦	MHSs: Conformance Testing
CCITT X.407♦	MHSs - Abstract Service Definition Conventions (ISO 10021-3, MOTIS)
CCITT X.408♦	MHSs - Encoded Information-Type Conversion Rules
CCITT X.409♦	MHSs - Presentation Transfer Syntax and Notation [replaced by X.208 (ISO 8824 with DAD 1) and X.208 (ISO 8825 with DAD 1)]
CCITT X.410♦	MHSs - Remote Operations and Reliable Transfer Server [replaced by X.218 (ISO 9066-1), X.219 (ISO 9072-1), X.228 (ISO 9066-2), and X.229 (ISO 9072-2)]
CCITT X.411♦	MHSs - Message Transfer Layer (see ISO 10021-4)
CCITT X.413♦	MHSs - Message Store: Abstract Service Definition (ISO 10021-5, MOTIS)
CCITT X.419♦	MHSs: Protocol Specifications (ISO 10021-6, MOTIS)
CCITT X.420♦	MHSs - Interpersonal Messaging User Agent Layer (ISO 10021-7, MOTIS)
CCITT X.430♦	MHSs - Access Protocol for Teletex Terminals
CCITT F.400	Message Handling System and Service Overview
CCITT F.401	Naming and Addressing for Public Message Handling Services
CCITT F.410	The Public Messaging Transfer Service
CCITT F.415	Intercommunication with Public Physical Delivery Services
CCITT F.420	The Public Interpersonal Messaging (IPM) Service
CCITT F.421	Intercommunication Between the IPM Service and the Telex Service
CCITT F.422	Intercommunication Between the IPM Service and the Teletex Service
CCITT F.500	International Public Directory Services

H. MESSAGE ORIENTED TEXT INTERCHANGE SYSTEM (MOTIS):[34]

ISO 10021-1♦	MOTIS - Part 1: System and Service (CCITT X.400), 1990
ISO 10021-2♦	MOTIS - Part 2: Overall Architecture (CCITT X.402), 1990
ISO 10021-3♦	MOTIS - Part 3: Abstract Service Definition Conventions (CCITT X.407), 1990
ISO 10021-4♦	MOTIS - Part 4: Message Transfer System - Abstract Service Definition and Procedures (CCITT X.411), 1990
ISO 10021-5♦	MOTIS - Part 5: Message Store - Abstract Service Definition (CCITT X.413), 1990
ISO 10021-6♦	MOTIS - Part 6: Protocol Specifications (CCITT X.419), 1990
ISO 10021-7♦	MOTIS - Part 7: Interpersonal Message System (CCITT X.420), 1990
DP xxxx	Mailbox Access Service and Protocol

[34] DIS 8505♦, DIS 8883♦, and DIS 9065♦ are not included in the MOTIS list, since they have been superceded by the other standards included in this list.

I. MANUFACTURING MESSAGE SPECIFICATION:

ISO 9506-1♦	Manufacturing Message Specification - Part 1: Service Definition, 1990
ISO 9506-2♦	Manufacturing Message Specification - Part 2: Protocol Specification, 1990

J. FILE TRANSFER, ACCESS AND MANAGEMENT (FTAM):

ISO 8571-1♦	FTAM - Part 1: General Introduction	
	AM 1♦	Filestore Management, July 1991
	DAM 2♦	Overlapped Access, June 1991 [SC21 N 5872]
	PDAM 3	Service Enhancement, July 1991 [SC21 N 6218)
	WDAM 4	Enhancement to FTAM Security Services [SC21 N 5155, July 1990] (CD text expected October 1992)
ISO 8571-2♦	FTAM - Part 2: Virtual Filestore Definition	
	AM 1♦	Filestore Management, July 1991
	DAM 2♦	Overlapped Access, June 1991 [SC21 N 5873]
	PDAM 3	Service Enhancement, July 1991 [SC21 N 6219)
	WDAM 4	Enhancement to FTAM Security Services [SC21 N 5155, July 1990] (CD text expected October 1992)
ISO 8571-3♦	FTAM - Part 3: File Service Definition	
	AM 1♦	Filestore Management, July 1991
	DAM 2♦	Overlapped Access, June 1991 [SC21 N 5874]
	PDAM 3	Service Enhancement, July 1991 [SC21 N 6220)
	WDAM 4	Enhancement to FTAM Security Services [SC21 N 5155, July 1990] (CD text expected October 1992)
ISO 8571-4♦	FTAM - Part 4: File Protocol Specification	
	AM 1♦	Filestore Management, July 1991
	DAM 2♦	Overlapped Access, June 1991 [SC21 N 5875]
	PDAM 3	Service Enhancement, July 1991 [SC21 N 6221)
	WDAM 4	Enhancement to FTAM Security Services [SC21 N 5155, July 1990] (CD text expected October 1992)
ISO 8571-5:1990(E)	FTAM - Part 5: Protocol Implementation Conformance Statement Proforma [SC21 N 5493, November 1990]	
	WDAM 1♦	Filestore Management, July 1990
	WDAM 2♦	Overlapped Access, July 1990 [PDAM expected November 1991]
	WDAM 3	Service Enhancement [SC21 N 5614, January 1990] (CD text expected October 1992)
	WDAM 4	Enhancement to FTAM Security Services [SC21 N 5155, July 1990] (CD text expected October 1992)
ISO 10170-1♦	Conformance Test Suite for the FTAM Protocol - Part 1: Test Suite Structure and Test Purposes, June 1991 [SC21 N 6269]	
WD 10170-2♦	Conformance Test Suite for the FTAM Protocol - Part 2: FTAM Abstract Test Suite [SC21 N 3665, June 1989] (CD text expected in 1991)	
WD 10170-3♦	Conformance Test Suite for the FTAM Protocol - Part 3: ACSE Abstract Test Suite Embedded Under FTAM (CD text expected June 1992)	
WD 10170-4♦	Conformance Test Suite for the FTAM Protocol - Part 4: Presentation Abstract Test Suite Embedded Under FTAM (CD text expected June 1992)	

WD 10170-5♦	Conformance Test Suite for the FTAM Protocol - Part 5: Session Abstract Test Suite Embedded Under FTAM (CD text expected June 1992)
ISP 10607-1	ISPs - AFT nn - File Transfer, Access, and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by FTAM, April 1990 [SGFS N 131] (submitted by SPAG; ISP accepted December 1990)
ISP 10607-2	ISPs - AFT nn - File Transfer, Access, and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes, April 1990 [SGFS N 131] (submitted by SPAG; ISP accepted December 1990)
	AD 1 Additional Definitions, December 1990 [balloted March 1991]
ISP 10607-3	ISPs - AFT nn - File Transfer, Access, and Management - Part 3: AFT 11 - Simple File Transfer Service (Unstructured), April 1990 [SGFS N 131] (submitted by SPAG; ISP accepted December 1990)
ISP 10607-4	ISPs - AFT nn - File Transfer, Access, and Management - Part 4: AFT 12 - Positional File Transfer Service, July 1991
	AD 1 Additional Definitions, July 1990 [SGFS N 245]
ISP 10607-5	ISPs - AFT nn - File Transfer, Access, and Management - Part 5: AFT 22 - Positional File Access Service, July 1991
ISP 10607-6	ISPs - AFT nn - File Transfer, Access, and Management - Part 6: AFT 12 - File Management Service, July 1991
IST21 N 2731	Proposed EN 41204, Simple File Transfer Service, April 1991
SC21 N 3372	Sharing an Association Between FTAM and Other ASE, February 1989 [SC21/WG5]
SC21 N 4162	Proposal for a NWI for Enhancement of FTAM Services to Satisfy Additional User Requirements, December 1989
SC21 N 4184	Request for National Body Comment on Security Enhancements to FTAM, SC21/WG5, November 1989
SC21 N 4192	Proposed FTAM Document Type to Support CGM, SC21/WG5, December 1989
SC21 N 5155	Enhancement of FTAM Security Services, New Work Item Proposal, SC21/WG5, July 1990
SC21 N 5164	Planned Work Schedule for FTAM, SC21/WG5, June 1990
SC21 N 5165	FTAM Constraint Set and Document Types for CGM, SC21/WG5, June 1990
SC21 N 5189	Liaison Statement to JTC1/SWG-EDI on EDIFACT Document Types for FTAM, SC21/WG5, June 1990
SC21 N 6224	Proposed EDIFACT/FTAM Document Type, WG5, July 1991
IST/21 N 2514	International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by FTAM, Project Editor, January 1991
IST/21 N 2742	International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes, Project Editor, January 1991
IST/21 N 2743	International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 3: AFT 11 - Simple File Transfer Service (Unstructured), Project Editor, January 1991
JTC1 N 955	Amendment to ISO 8671 to Deal with Authentication and Access Control in FTAM (new work item)

K. VIRTUAL TERMINAL (VT):

ISO 9040♦	Virtual Terminal Service - Base Class (April 1990 Revised Edition incorporates AD 1)	
	AD 1♦	Extended Facility Set
	AM 2♦	Additional Functional Units, July 1991
ISO 9041♦	Virtual Terminal Protocol - Basic Class (April 1990 Revised Edition incorporates AD 1)	
	AD 1♦	Extended Facility Set
	AM 2♦	Additional Functional Units, July 1991
DIS 9041-2♦	Virtual Terminal Protocol - Part 2: PICS Proforma, April 1991 [SC21 N 5702] (IS text expected in February 1992)	
SC21 N 3365	Guide to ISO Virtual Terminal Standards, February 1989 [SC21/WG5]	
SC21 N 5162	Conformance Test Suite for the VT Protocol, July 1990	
SC21 N 6227	Virtual Terminal Support of ODA, WG5, July 1991	
ED xxx	Application Function A/4113, Basic Class VT, A-mode X3 Functional Standard, European Workshop for Open Systems [EWOS EG VT/90/112], Final Draft, November 1990	
ENV 41 208	Information System Interconnection - Basic Class Virtual Terminal - S-mode Forms - Part 1: Virtual Terminal Service, European Prestandard, December 1990	
ENV 41 208	Information System Interconnection - Basic Class Virtual Terminal - S-mode Forms - Part 2: Check List, European Prestandard, December 1990	
ENV 41 208	Information System Interconnection - Basic Class Virtual Terminal - S-mode Forms - Part 3: Underlying Layers Checklist, European Prestandard, December 1990	
ENV 41 209	Information System Interconnection - Basic Class Virtual Terminal - Common Control Objects, European Prestandard, December 1990	

L. TERMINAL MANAGEMENT (TM), VISUAL DISPLAY TERMINAL (VDT), AND X-WINDOWS:

ISO 9241-1	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 1: Introduction
ISO 9241-2	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 2: Task Requirements
DIS 9241-3	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 3: Visual Display Requirements
DIS 9241-4	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 4: Keyboard Requirements
CD 9241-5	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 5: Workstation Layout and Postural Requirements
CD 9241-6	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 6: Environmental Requirements
CD 9241-7	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 7: Display Requirements with Reflections
CD 9241-8	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 8: Requirements for Displayed Colors

CD 9241-9	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 9: Requirements for Non-Keyboard Input Devices
WD 9241-10	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 10: Dialogue Principles
CD 9241-11	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 11: Usability Statements
CD 9241-12	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 12: Presentation of Information
WD 9241-13	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 13: User Guidance
CD 9241-14	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 14: Menu Dialogues
WD 9241-15	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 15: Command Dialogues
WD 9241-16	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 16: Direct Manipulation Dialogues
WD 9241-17	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 17: Form-Filling Dialogues
9241-18	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 18: Question and Answer Dialogues (not yet started)
9241-19	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 19: Natural Language Dialogues (not yet started)
CD 10184-1.2	Terminal Management - Model, July 1991 [SC21 N 4176, June 1990] (DIS text expected in July 1992, IS in July 1993)
WD 10184-2	Terminal Management - Service, July 1991 [SC21 N 4176, June 1990] (CD text expected July 1992, DIS in December 1992, IS in December 1993)
WD 10184-3	Terminal Management - Protocol, July 1991 [SC21 N 4176, June 1990] (CD text expected July 1992, DIS in December 1992, IS in December 1993)
IST21 N 2744	A Mapping of the X Window System over and OSI Stack, EWOSEG VT, April 1991
SC21 N 3369	Terminal Management (TM) Issues List, February 1989 [SC21/WG5]
SC21 N 3381	Statement on TM Strategic Direction, February 1989 [SC21/WG5]
SC21 N 3383	Relationship Between TM and User Interfaces, February 1989 [SC21/WG5]
SC21 N 3930	Liaison Statement from JTC1/SC18 to JTC1/SC21/WG5 on Comments on Terminal Management, SC18/WG4, October 1989
SC21 N 4188	Response to SC18/WG4 N 1183, Comments on Terminal Management, and SC18/WG3 and CCITT SG VII(Q27) Liaison Statement on Terminal Management, SC21/WG5, December 1989
SC21 N 4189	Comments on the Integration of X-Windows into the OSI Environment, December 1989

M. JOB TRANSFER AND MANIPULATION (JTM):

ISO 8831♦	Job Transfer and Manipulation Concepts and Services, June 1989
DIS 8831.2	Job Transfer and Manipulation (JTM) Concepts and Service, June 1991 (IS second edition text expected November 1991)
ISO 8832♦	Specification of the Basic Class Protocol for Job Transfer and Manipulation

AM 1♦	JTM Full Protocol Specification, May 1990 [SC21 N 5225, text with amendment incorporated; and SC21 N 5224, amendment alone] (IS text expected November 1991)
SC21 N 4603	Position on Reassessment of JTM Full Class Protocol, AFNOR, March 1990
SC21 N 4641	U.S. Position on JTM Reassessment, March 1990
SC21 N 4679	Reassessment of Project 1.21.13.03 (JTM Full Class), SC21, June 1990

N. TELEMATIC SERVICES:

CCITT F.200♦	Teletex Service
CCITT F.200/C♦	Teletex Service, Annex C: Mixed Mode of Operation
CCITT F.201♦	Internetworking Between the Teletex Service and the Telex Service
CCITT T.60♦	Terminal Equipment for Use in the Teletex Service
CCITT T.63♦	Provision for Verification of Teletex Compliance
CCITT T.72♦	Terminal Capabilities for Mixed Mode of Operation
CCITT T.90♦	Teletex Requirements for Internetworking with the Telex Service
CCITT T.91♦	Teletex Requirements for Real-Time Internetworking with the Telex Service in a Packet-Switched Network Environment
CCITT T.330♦	Telematic Access to Interpersonal Messaging System
CCITT X.430♦	MHS, Access Protocol for Teletex Terminals

O. INFORMATION RESOURCE DICTIONARY SYSTEM (IRDS):

DP 8800-1	Information Resource Dictionary System (IRDS) - Part 1: Command Language and Panel Interface, April 1987 [SC21 N 1789] (projected suspended until the IRDS services interface reaches DIS status; the command language and panel interface are expected to be split into separate standards)
ISO 10027♦	IRDS Framework, June 1990 [SC21 N 4727, May 1990]
DIS 10728	IRDS - Services Interface, July 1991 [SC21 N 5147, July 1990]
WD xxxx	IRDS - Design Support for SQL Applications (CD text expected January 1991)
WD xxxx	IRDS - Export/Import (CD text expected November 1990)
WD xxxx	IRDS - Extensions, July 1990 [SC21 N 5139] (CD text expected June 1992)
IST21 N 2499	Report on the Anaheim IRDS Services Interface Meetings, David JL Gradwell, 18 January 1991
IST21 N 2361	UK Comment Accompanying Vote of Disapproval on CD 10728, Information Resource Dictionary System Services Interface, UK, October 1990
JTC1 N 1021	Proposal for a New Work Item: Data Management Export/Import for SQL and IRDS, October 1990
JTC1 N 1023	Proposal for a New Work Item: Information Resource Dictionary Systems (IRDS), October 1990
JTC1 N 1252	Summary of Voting on Document JTC1 N 1021, Proposal for a New Work Item on Data Management Export/Import for SQL and IRDS, JTC1 Secretariat, February 1991
JTC1 N 1254	Summary of Voting on Document JTC1 N 1023, Proposal for a New Work Item on Information Resource Dictionary Systems (IRDS), JTC1 Secretariat, February 1991

SC21 N 3344	IRDS Rapporteur Group Position on Need for IRDS Specialization for RDA, April 1989 [SC21/WG3]
SC21 N 4806	Use of External Data Transfer Systems for Shadow Updates, May 1990
SC21 N 5137	Data Management Export/Import for SQL and IRDS, SC21/WG3, October 1990 (new work item)
SC21 N 5139	IRDS Extensions, SC21/WG3, July 1990 (new work item)
SC21 N 5437	Proposed Amendment to CD 10728 to Cover Error States, UK, November 1990
SC21 N 5438	CD 10728 Clause 6, Proposed Revision 1, UK, November 1990
SC21 N 5439	Proposal to Merge Working Set and Definition Working Set, UK, November 1990
SC21 N 5574,	Interim Minutes of the CD 10728 Editing Meeting, Secretary, February 1991
SC21 N 6252	Revision of the IRDS Framework, WG3, July 1991 (new work item)

P. REMOTE DATABASE ACCESS (RDA):

DIS 9579-1♦	Remote Database Access (RDA) - Part 1: Generic Model, Service, and Protocol, July 1991 [SC21 N 4282, March 1990] (IS text expected in 1992)
DIS 9579-2♦	Remote Database Access (RDA) - Part 2: SQL Specialization, July 1991 [SC21 N 4281, March 1990] (IS text expected in 1992)
	WDAM 1 Support for SQL2, March 1990 (CD text expected June 1993)
WDTR xxxx♦	Remote Database Access Tutorial, January 1989 [SC21 N 3343]
SC21 N 3344	IRDS Rapporteur Group Position on Need for IRDS Specialization for RDA, April 1989 [SC21/WG3]
SC21 N 3346	RDA Use of Remote Operation Notation of ROSE, December 1988 [SC21/WG3]
SC21 N 3351	RDA Requirements for CCR, December 1988 [SC21/WG3]
SC21 N 3352	Harmonization of RDA and TP, December 1988 [SC21/WG3]
SC21 N 5138	RDA Support for Shared DBL Statements, October 1990 (new work item)

Q. DATA MANAGEMENT CONCEPTS:

TR 9007	Concepts and Terminology for the Conceptual Schema and the Information Base
DIS 10032♦	Reference Model of Data Management, Revised Draft, May 1991 [SC21 N 5991] (balloting ends 4 January 1992)
WDTR xxxx	Tutorial on the Reference Model for Data Management (CDTR expected June 1992)
IST21 N 2880	Interim Report on the Feasibility of Profiling Database Enquiry, EWOSPT N 014, June 1991
SC21 N 197	Concepts and Terminology for the Conceptual Schema and the Information Base, TC97/SC5, March 1982
SC21 N 236	Assessment Guidelines for Conceptual Schema Language Proposals, TC97/SC21/WG5-3, 31 August 1985
SC21 N 3358	Generic Data Management Export/Import
SC21 N 3806	Request for New Question on Conceptual Schema Standardization, September 1989
SC21 N 3903	Modelling, Specification, Use, and Role of Conceptual Schemas, October 1989

SC21 N 4195	Draft WG3 Position on Conceptual Schema Question, February 1990
SC21 N 4199	Liaison Statement to JTC1/SC1 on SC21/WG3 Terminology, contains the Reference Model on Data Management (dated 8 August 1989), February 1990
SC21 N 4280	Proposed New Work Item: Conceptual Data Modelling Facility, SC21/WG3, February 1990
SC21 N 4383	Development of the Extended Information Model, January 1990
SC21 N 4511	U.S. Comments on Conceptual Schema, ANSI, March 1990
SC21 N 4524	Consideration of the Data Management Component of Application Standards, Workshop of Distributed Applications, April 1990
SC21 N 4593	Metadata Use and Standards for Managing Metadata, ANSI, April 1990
SC21 N 5137	Data Management Export/Import for SQL and IRDS, SC21/WG3, July 1990 (new work item)
SC21 N 5193	Conceptual Schema HOD/C Meeting report Held on 31 May 1990 in Seoul, July 1990
SC21 N 5764	Information Retrieval, Transfer and Management for USA (ANSI), April 1991
SC21 N 5851	USA Contribution to SC21 on the Conceptual Schema Topic, USA, April 1991

R. DATABASE LANGUAGES AND CONCEPTS:

ISO 8907♦	Database Language NDL, June 1987
ISO 9075♦	Database Language SQL, April 1989 (incorporates AD 1) [SC21 N 3158]
	AD 1♦ Integrity Enhancements
DIS 9075.2♦	Database Language SQL2, July 1991 [SC21 N 5739] (IS status expected June 1992)
WD 9075.3♦	Database Language SQL3 (CD expected June 1993)
IST21 N 2880	Interim Report on the Feasibility of Profiling Database Enquiry, EWOSPT N 014, June 1991
SC21 N 4672	Liaison Statement on Character Internationalization, SC21/WG3 on Database Language Extended SQL, 26 May 1990
SC21 N 5137	Data Management Export/Import for SQL and IRDS, SC21/WG3, July 1990 (new work item)

S. DISTRIBUTED TRANSACTION PROCESSING (TP):

DIS 10026-1.2♦	Distributed Transaction Processing (TP) - Part 1: Model, February 1991 [SC21 N 5671] (IS text expected June 1992)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Security, WDAMs, January 1990 [SC21 N 4163]
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Association Management, WDAMs, January 1990 [SC21 N 4164] (CD text expected June 1992)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Heuristic Decisions, WDAMs, January 1990 [SC21 N 4167]
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Commitment Optimization, WDAMs, January 1990 [SC21 N 4168]
DIS 10026-1/3	Draft Amendments to Parts 1-3: Distributed Transaction Processing Dialogue Recovery and User Suspension of a Dialogue, WDAMs, January 1990 [SC21 N 4170] (CD text expected June 1992)

DIS 10026-1/3	Draft Amendments to Parts 1-3: Distributed Transaction Processing Savepoints, January 1990 [SC21 N 4171] (new work item; not accepted by JTC1, June 1990)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Sub-Transactions, WDAMs, July 1990 [SC21 N 5156] (CD text expected January 1992)
DIS 10026-1/4	Draft Amendments to Parts 1-3: Transaction Processing Separate Data and Commit Associations, WDAMs, July 1990 [SC21 N 5156] (CD text expected May 1993)
DIS 10026-2.2♦	Distributed Transaction Processing (TP) - Part 2: Service Definition, February 1991 [SC21 N 5673]
	WDAM 1 Commit Optimizations, February 1991 [SC21 N 5187]
DIS 10026-3♦	Distributed Transaction Processing (TP) - Part 3: Transaction Processing Protocol Specification, , February 1991 [SC21 N 5675]
	WDAM 1 Commit Optimizations, February 1991 [SC21 N 5187]
CD 10026-4	Distributed Transaction Processing (TP) - Part 4: PICS Proforma, July 1990 [SC21 N 5159]
CD 10026-5	Distributed Transaction Processing (TP) - Part 5: Application Context Proforma, February 1991 [SC21 N 5160]
CD 10026-6	Distributed Transaction Processing (TP) - Part 6: Unstructured Data Transfer, July 1991 [SC21 N 4166, January 1990; JTC1 N 775] (DIS text expected in October 1991, IS in October 1992
WD 10026-7	Distributed Transaction Processing (TP) - Part 7: Other Data Transfer, January 1990 [SC21 N 4166] (new work item; CD text expected November 1992]
WD 10026-Z	Data Transfer for OSI TP - Other Transfer Modes, January 1990 [SC21 N 4166] (new work item; CD text expected June 1992)
WD xxxx-1	Conformance Test Suite for the TP Protocol, Part 1: Test Suite Structure and Test Purposes, 6th Working Draft, June 1990 [SC21 N 5162] (formal WD text expected February 1991, CD text June 1992)
WD xxxx-2	Conformance Test Suite for the TP Protocol, Part 2: Abstract Test Suites, January 1990 [SC21 N 4172]
IST21 N 2765	EWOS Proposed Taxonomy for OSI-TP, May 1991
IST21 N 2879	Status of ISO Work on OSI TP Standards, EWOS/EGTP/90/19r, June 1991
SC21 N 4167	TP Heuristic Decisions, January 1990 [PDAMs dependent on National Body input]
SC21 N 4168	TP Commitment Optimizations, January 1990 [PDAMs expected June 1991]
SC21 N 4170	TP Dialogue Recovery and User Suspension of a Dialogue, January 1990 [PDAMs expected June 1992]
SC21 N 4171	TP Savepoints, January 1990 [NWI not accepted]
SC21 N 5156	TP Sub-Transactions, New Work Item Proposal, SC21/WG5, July 1990 [PDAMs expected January 1992]
SC21 N 5157	TP Separate Data and Commit Associations, New Work Item Proposal, SC21/WG5, July 1990 [PDAMs expected May 1993]
SC21 N 5170	OSI TP Association Management - Statement of Requirements, SC21/WG5, June 1990 [PDAMs expected June 1992]
SC21 N 5171	OSI TP Security - Statement of Requirements, SC21/WG5, June 1990
SC21 N 5172	Combined Use of RPC and OSI TP, SC21/WG5, June 1990
SC21 N 5173	Working Draft Unstructured Data Transfer (UDT) for TP, SC21/WG5, May 1990

SC21 N 5176	OSI TP Security, New Work Item, June 1990
SC21 N 5177	OSI TP Association Management - Revised New Work Item, SC21/WG5, June 1990
SC21 N 5179	Proposed Replacement Text for the NWI Proposal on Commitment Optimizations in SC21 N 4168 (JTC1 N 631), SC21/WG5, June 1990
SC21 N 5183	Combined Use of CMISE and OSI TP, SC21/WG5, June 1990
SC21 N 5184	Queued Data Transfer for TP, SC21/WG5, May 1990
SC21 N 5833	TP/CCR Extensions - Proposed Restructure for Future Work, USA, April 1991
SC21 N 5836	USA Discussion Paper on Subtransactions, April 1991
SC21 N 5845	Questions and Issues Concerning Combined Use of CMISE and TP, USA, April 1991
SC21 N 6226	TP Statement of Results
SC21 N 6231	Preliminary Model and Service Definition for Queued Data Transfer, WG5, July 1991
SC21 N 6232	Preliminary TP Security Model, WG5, June 1991
SC21 N 6236	Requirements and Issues for Subtransactions, WG5, June 1991
SC21 N 6239	Working Document for TP Commit Optimization, WG5, June 1991
SC21 N 6240	Requirements and Issues on Separation of Data and Commitment Flows, WG5, June 1991
SC21 N 6243	TP Testing Methodology (Revised), WG5, June 1991
SC21 N 6244	Conformance Test Suite for the TP Protocol - Part 1: Test Suite Structure and Test Purposes, WG5, June 1991

T. OPEN DISTRIBUTED PROCESSING (ODP):

WD 10746-1♦	Basic Reference Model for Open Distributed Processing - Part 1: Introduction (proposal for new work item, 1987) [SC21 N 1547]
CD 10746-2♦	Basic Reference Model for Open Distributed Processing - Part 2: Concepts and Modelling Tools (proposal for new work item, 1987) [SC21 N 6097]
WD 10746-3♦	Basic Reference Model for Open Distributed Processing - Part 3: Framework for ODP Standards (proposal for new work item, 1987) [SC21 N 6080] (CD text expected June 1992)
WD 1076-4♦	Basic Reference Model for Open Distributed Processing - Part 4: User Guide (proposal for new work item, 1987) [SC21 N 1547]
WD 10746-5	Basic Reference Model for Open Distributed Processing - Part 5: Architectural Semantics, Specification Techniques, and Formalisms [SC21 N 6082] 30 May 1991. (CD expected May 1993)
SC21 N 1889	ODP: Proposed Revised Text for the NWI on the Basic Reference Model of Open Distributed Processing, April 1987
SC21 N 2507	ODP: Report on Topic 1 - The Problem of Distributed Processing, March 1988 [SC21/WG7]
SC21 N 2511	ODP: Definitions and Glossary - March 1988 Version, March 1988 [SC21/WG7]
SC21 N 3194	ODP: Working Document on Topic 2.3 - Framework of Abstractions, December 1988 [SC21/WG7]
SC21 N 3202	ODP: Recommendations of SC21/WG7, Sydney, December 1988
SC21 N 3288	ODP: Working Document on Topic 2.2 - Properties and Design Freedoms, December 1988 [SC21/WG7]

SC21 N 3288	ODP: Working Document on Topic 2.2 - Properties and Design Freedoms, December 1988 [SC21/WG7]
SC21 N 3801	Support Environment for Open Distributed Processing, ECMA, September 1989
SC21 N 4019	ODP: Topics List - November 1989 Version - for the Basic Reference Model of Open Distributed Processing, November 1989
SC21 N 4020	ODP: List of Open and Resolved Issues - November 1989 Version, December 1989
SC21 N 4021	ODP: Document Register and Bibliography - November 1989 Version, December 1989
SC21 N 4022	ODP: Working Document on Topic 4.1 - Structures and Functions, December 1989 [superceded by SC21 N 4885]
SC21 N 4023	ODP: Working Document on Topic 6.1 - Modelling Techniques and Their Use in ODP, December 1989
SC21 N 4024	ODP: Working Document on Topic 6.2 - Formalisms and Specifications, December 1989
SC21 N 4025	ODP: Working Document on Topic 8.1 - Draft Basic Reference Model of Open Distributed Processing, December 1989
SC21 N 4026	ODP: Recommendations of SC21/WG7, Florence, December 1989
SC21 N 4027	ODP: Meeting Minutes of the Florence Working Group Meeting of WG7, December 1989
SC21 N 4028	ODP: SC21/WG7 Convener's Report to SC21 Plenary Meeting, December 1989
SC21 N 4029	ODP: Liaison Statement to JTC1/TSG-1 on IAP, December 1989
SC21 N 4030	ODP: Cooperation between SC21/WG7 and CCITT SG VII (Q19/DAF), December 1989
SC21 N 4031	ODP: Session Report on Joint Meeting on FDT, December 1989
SC21 N 4032	ODP: Liaison Statement to JTC1/SWG-EDI on EDI Modelling, December 1989
SC21 N 4033	ODP: Proposal for Future Cooperation Between SC21/WG6 and SC21/WG7 on ULA and ODP, December 1989
SC21 N 4564	ODP: Liaison Statement to SC21/WG7 on Relationship of DAF Architecture/Infrastructure with ODP Topic 4 - Functions and Interfaces, CCITT SG VII, March 1990
SC21 N 4655	Architectural Semantics for ODP - Reassessment Report, SC21/WG7, April 1990
SC21 N 4885	ODP: Working Document in Topic 4.3 - Function and Interface Definitions, 13 July 1990
SC21 N 5564	Proposal for a New Work Item: ODP Trader - A Standard to Define the Role and Function of the Trader in Open Distributed Processing (ODP), November 1990
SC21 N 5840	Comments on the Relationship Between Concepts and Models for OSI and ODP, USA, April 1991
SC21 N 6079	CD 10746-2, Reference Model of ODP - Part 2: Descriptive Model, SC 21/WG 7, 30 May 1991
SC21 N 6080	Working Draft for Part 3 of the Reference Model for ODP, SC 21/WG 7, 30 May 1991
SC21 N 6083	Working Document Partial Text for Part 1 and Part IV of the Reference Model for ODP, SC 21/WG 7, 30 May 1991

SC21 N 6226 Rev	OSI Distributed Transaction Processing Statement of Results, June 1991

U. GRAPHICAL KERNEL SYSTEM (GKS):

ISO 7942	Graphical Kernel System (GKS) Functional Description
	DAD 1 Audit Trail Metafile
ISO 8651-1	GKS Language Bindings - Part 1: FORTRAN
ISO 8651-2	GKS Language Bindings - Part 2: Pascal
ISO 8651-3	GKS Language Bindings - Part 3: Ada
DIS 8651-4	GKS Language Bindings - Part 4: C (ballot closed 2 December 1990)
ISO 8805	GKS for Three Dimensions (GKS-3D) Functional Description
	WDAD 1 Name Set Addendum
DIS 8806-1	GKS-3D Language Bindings - Part 1: FORTRAN
DIS 8806-3	GKS-3D Language Bindings - Part 3: Ada
DIS 8806-4	GKS-3D Language Bindings - Part 4: C (ballot closed 2 December 1990)

V. PROGRAMMER'S HIERARCHICAL INTERACTIVE GRAPHICS SYSTEM (PHIGS):

ISO 9592-1	Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 1: Functional Description
	AM 1 Amendment 1: PHIGS Plus Support
ISO 9592-2	PHIGS Language Bindings - Part 2: Archive File Format
	AM 1 Amendment 1: PHIGS Plus Support
ISO 9592-3	PHIGS Language Bindings - Part 3: Clear-Text Encoding of Archive File
	AM 1 Amendment 1: PHIGS Plus Support
ISO 9592-4	Part 4: PHIGS Plus [SC24 N 224] (ballot closed 1 September 1990)
ISO 9593-1	PHIGS Language Bindings - Part 1: FORTRAN Binding, August 1990
DIS 9593-2	PHIGS Language Bindings - Part 2: Extended Pascal (awaiting DIS ballot)
ISO 9593-3	PHIGS Language Bindings - Part 3: Ada, July 1990
DIS 9593-4	PHIGS Language Bindings - Part 4: C (ballot closed 21 March 1991)

W. DIALOGUES WITH GRAPHICAL DEVICES:

DIS 9636-1	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 1: Overview, Profiles, and Conformance (ballot closed 8 September 1990)
DIS 9636-2	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 2: Control, Negotiation, and Errors (ballot closed 8 September 1990)
DIS 9636-3	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 3: Output and Attributes (ballot closed 8 September 1990)
DIS 9636-4	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 4: Segmentation (ballot closed 8 September 1990)

DIS 9636-5	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 5: Input and Echoing (ballot closed 8 September 1990)
DIS 9636-6	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 6: Raster
WD 9636-8	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 8: FORTRAN Language Binding of CGI
WD 9636-11	Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 11: C Language Binding of CGI
CD 11072	Information Processing Systems - Computer Graphics - Reference Model of Computer Graphics, 1991
CD 10641	Conformance Testing of Implementations of Graphics Standards, 1991

X. DOCUMENT EXCHANGE--ODA, ODIF, DOAM, DFR, AND DTAM:

ISO 8211	Specification for a Data Descriptive File for Information Interchange	
ISO 8613-1♦	Office Document Architecture (ODA) and Interchange Format - Part 1: Introduction and General Principles	
	DAM 1	Amendment 1: Document Application Profile Proforma and Notation (ballot closed 1 July 1990)
	DAM 2	Amendment 2: Conformance Testing Methodology
ISO 8613-2♦	ODA and Interchange Format - Part 2: Document Structures	
	PDAD 1	Formal Specification of ODA Document Structures
ISO 8613-3♦	ODA and Interchange Format - Part 3: Document Processing Reference Model	
ISO 8613-4♦	ODA and Interchange Format - Part 4: Document Profile	
ISO 8613-5♦	ODA and Interchange Format - Part 5: Office Document Interchange Format (ODIF)	
ISO 8613-6♦	ODA and Interchange Format - Part 6: Character Content Architectures	
ISO 8613-7♦	ODA and Interchange Format - Part 7: Raster Graphics Content Architectures	
ISO 8613-8♦	ODA and Interchange Format - Part 8: Geometric Graphics Content Architectures	
ISO 8613-9	ODA and Interchange Format - Part 9: Audio Content Architecture (new work item)	
ISO 8613-10	ODA and Interchange Format - Part 10: Formal Specifications	
	DAM 1	Amendment 1: Formal Specification of the Document Profile (ballot closed 1 March 1991)
	DAM 2	Amendment 2: Formal Specification of the Raster Graphics Content Architectures (ballot closed 1 March 1991)
ISO 10031-1	Distributed Office Applications Model (DOAM) - Part 1: General Model, 1991	
ISO 10031-2	Distributed Office Applications Model (DOAM) - Part 2: Referenced Data, 1991	
ISO 10166-1	Document Filing and Retrieval (DFR) - Part 1: Abstract Service Definition and Procedures, 1991 [SC18 N 2069, February 1989]	
ISO 10166-2	Document Filing and Retrieval (DFR) - Part 2: Protocol Specification, 1991 [SC18 N 2070, February 1989]	
DTR 10183	ODA and Interchange Format - Testing Methodology and Abstract Cases - Implementation Testing, 1991	
DP 10303	Standard for Exchange of Product Model Data (STEP)	

CD 10744	Representation of Duration and Synchronization in Time-Dependent Documents
SC21 N 4472	Liaison Statement from JTC1/SC18 to JTC1/SC21 on Changes to ASN.1, SC18/WG3 (title is in error--changes are for ODA, ISO 8613) February 1990
SC21 N 6227	Virtual Terminal Support of ODA, WG5, July 1991
CCITT T.400	Introduction to Document Architecture, Transfer and Manipulation
CCITT T.411	Open Document Architecture (ODA) and Interchange Format - Introduction and General Principles (see ISO 8613-1)
CCITT T.412	Open Document Architecture (ODA) and Interchange Format - Document Structures (see ISO 8613-2)
CCITT T.414	Open Document Architecture (ODA) and Interchange Format - Document Profile (see ISO 8613-4)
CCITT T.415	Open Document Architecture (ODA) and Interchange Format - Open Document Interchange Format (ODIF) (see ISO 8613-5)
CCITT T.416	Open Document Architecture (ODA) and Interchange Format - Character Content Architectures (see ISO 8613-6)
CCITT T.417	Open Document Architecture (ODA) and Interchange Format - Raster Graphics Content Architectures (see ISO 8613-7)
CCITT T.418	Open Document Architecture (ODA) and Interchange Format - Geometric Graphics Content Architectures (see ISO 8613-8)
CCITT T.431	Document Transfer and Manipulation (DTAM) - Services and Protocols, Introduction and General Principles
CCITT T.432	DTAM - Services and Protocols, Service Definition
CCITT T.433	DTAM - Services and Protocols, Protocol Specification
CCITT T.441	DTAM - Operational Structure
CCITT T.501	Document Application Profile MM for the Interchange of Formatted Mixed Mode Documents (Mixed Mode)
CCITT T.502	Document Application Profile PM1 for the Interchange of Processible Form Documents (Teletex Processible Mode)
CCITT T.503	Document Application Profile for the Interchange of Group 4 Facsimile Documents

Y. PICTURE DESCRIPTION INFORMATION EXCHANGE:

ISO 8632-1	Computer Graphics Metafile (CGM): Metafile for the Storage and Transfer of Picture Description Information - Part 1: Functional Specification DAD 1 Audit Trail Metafile PDAD 2 3D Static Picture Capture Metafile
ISO 8632-2	CGM: Metafile for the Storage and Transfer of Picture Description Information - Part 2: Character Encoding
ISO 8632-3	CGM: Metafile for the Storage and Transfer of Picture Description Information - Part 3: Binary Encoding
ISO 8632-4	CGM: Metafile for the Storage and Transfer of Picture Description Information - Part 4: Clear Text Encoding
DIS 9281	Identification of Picture Coding Methods
CD 10918-1	Digital Compression and Coding of Continuous-Tone Still Images, Part 1: Requirements and Guidelines, February 1991
CD 10918-2	Digital Compression and Coding of Continuous-Tone Still Images, Part 2: Compliance Testing (expected to be published in 1991)

CD 11172	Coding of Moving Pictures and Associated Audio, December 1990
SC21 N 4192	Proposed FTAM Document Type to Support CGM, SC21/WG5, December 1989
SC21 N 5165	FTAM Constraint Set and Document Types for CGM, SC21/WG5, June 1990

Z. STANDARD GENERALIZED MARKUP LANGUAGE (SGML):

ISO 8879	Standard Generalized Markup Language (SGML), October 1986
	AM 1 Amendment 1, July 1988
ISO 9069	SGML Support Facilities - SGML Document Interchange Format (SDIF)
ISO 9070	SGML Support Facilities - Registration Procedures for Public Text Owner Identifiers, February 1990
TR 9573	SGML Support Facilities - Techniques for Using SGML
TR 10037	SGML and Text-Entry Systems - Guidelines for SGML Syntax-Directed Editing Systems (awaiting publication)
CD 10179	Document Style Semantics and Specification Language (DSSSL) (awaiting CD ballot)
CD 10180	Standard Page Description Language (SPDL) (awaiting CD ballot)

AA. OTHER APPLICATION LAYER STANDARDS:

CCITT X.3♦	Packet Assembly/Disassembly Facility (PAD) in a Public Data Network (PDN)
CCITT X.28♦	DTE/DCE Interface for a Start/Stop Mode DTE Accessing the PAD in a PDN Situated in the Same Directory
CCITT X.29♦	Procedures for the Exchange of Control Information and User Data Between a PAD and a Packet Mode or Another PAD

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IX. MISCELLANEOUS STANDARDS[35]

A. INTEGRATED SERVICES DIGITAL NETWORK (ISDN): GENERAL STANDARDS[36]

ISO 9574♦	Provision of the OSI Connection-Mode Network Service by Packet Mode Terminal Equipment Connected to an ISDN
CCITT I.110	General Structure of the I-Series Recommendations
CCITT I.111	Relationship With Other Recommendations Relevant to ISDNs
CCITT I.120	ISDNs
CCITT I.130	Attributes for the Characterization of Telecommunications Service Supported by an ISDN and Network Capabilities of an ISDN
CCITT I.210	Principles of Telecommunications Services Supported by an ISDN
CCITT I.211	Bearer Services Supported by an ISDN
CCITT I.212	Teleservices Supported by an ISDN
CCITT I.310	ISDN - Network Functional Principles
CCITT I.320	ISDN Protocol Reference Model
CCITT I.330	ISDN Numbering and Addressing Principles
CCITT I.331	Numbering Plan for the ISDN Era
CCITT I.410	General Aspects and Principles Relating to Recommendations on ISDN User-Network Interfaces

B. ELECTRONIC DATA INTERCHANGE (EDI):

ISO 9735	Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) - Application Level Syntax Rules
JTC1 N 1240	Multimedia and Hypermedia, Ms. M.A. Gray, February 1991
JTC1 N 1161	Technical Study Group on Multimedia and Hypermedia, USA, January 1991
JTC1 SWG-EDI N 177	Conceptual Model for Electronic Data Interchange Standards and Services, December 1990
SC21 N 3925	Liaison Statement to JTC1 SC21 from JTC1 SWG-EDI, JTC1 SWG-EDI, October 1989
SC21 N 4799	Letter for Information on Disposition of EDIMS Use of Directory, May 1990
SC21 N 5189	Liaison Statement to JTC1/SWG-EDI on EDIFACT Document Types for FTAM, SC21/WG5, June 1990
SC21 N 5635	Report of the Special Working Group on a Conceptual Model for Electronic Data Interchange Standards and Services (SWG-EDI), January 1991
SC21 N 6224	Proposed EDIFACT/FTAM Document Type, WG5, July 1991

[35] The symbol ♦ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

[36] A complete list of CCITT 1988 Recommendations on ISDN is provided in Appendix E, Section II.B.

C. TELEMATIC SERVICES:

DP 9071-1.2	Text and Office Systems - Basic and Optional Requirements - Part 1: Facsimile Equipment
DP 9071-2.2	Text and Office Systems - Basic and Optional Requirements - Part 2: Text Communications Terminals
CCITT T.0	Classification of Facsimile Apparatus for Document Transmission Over the Public Networks

D. VOCABULARY AND REPRESENTATIONS:

ISO 2382-9	Vocabulary - Part 9: Data Communications
CD 2382-17.3	Data Processing - Vocabulary - Part 17: Databases, third committee draft [SC21 N 1241], 11 February 1991
ISO 2382-18	Data Processing - Vocabulary - Part 18: Distributed Data Processing, 1987
DP 2382-26	Data Processing - Vocabulary - Part 26: OSI Architecture, September 1989 [SC21 N 3802]
ISO 3307	Representations of Time of the Day
ISO 3534	Statistics - Vocabulary and Symbols, 1977
ISO 4031	Representation of Local Time Differentials
ISO 6093	Representation of Numeric Values in Character Strings for Information Exchange
ISO 6523	Data Interchange - Structure for the Identification of Organizations
DP 7826	Representation of Data Elements
ISO 8211	Specification for a Data Descriptive File for Information Interchange
DIS 8601	Representation of Dates and Times
ISO 8790	Computer System Configuration Diagram Symbols and Conventions
DIS 9282-1	Coded Representation of Pictures - Part 1: Encoding Principles for Picture Representation in a 7- or 8-Bit Environment
DIS 9282-2	Coded Representation of Pictures - Part 2: Encoding Principles for Photographic Images
DTR 9544	Computer-Assisted Publishing - Vocabulary
SC21 N 4728	Collections of Definitions of OSI Vocabulary, SC21, April 1990

E. CODED CHARACTER SETS:

ISO 646	ISO 7-Bit Coded Character Set for Information Exchange
ISO 2022	ISO 7-Bit and 8-Bit Coded Character Sets - Code Extension Techniques
ISO 4873	8-Bit Code for Information Interchange - Structure and Rules for Implementation
DIS 6429	ISO 7-Bit and 8-Bit Coded Character Sets - Control Functions for Coded Character Sets
ISO 6936	Conversion Between the Two Coded Character Sets of ISO 646 and ISO 6937-2 and the CCITT International Telegraph Alphabet No. 2 (ITA2)
DIS 6936.2	Conversion Between the Two Coded Character Sets of ISO 646 and ISO 6937-2 and the CCITT International Telegraph Alphabet No. 2 (ITA2), Draft Second Edition
ISO 6937-1	Coded Character Sets for Text Communication - Part 1: General Introduction

ISO 6937-2	Coded Character Sets for Text Communication - Part 2: Latin Alphabetic and Non-Alphabetic Graphic Characters DAD 1 Addendum 1
DIS 6937-3	Coded Character Sets for Text Communication - Part 3: Control Functions for Page-Image Format
DIS 6937-7	Coded Character Sets for Text Communication - Part 7: Greek Graphic Characters
DIS 6937-8	Coded Character Sets for Text Communication - Part 8: Cyrillic Graphic Characters
ISO 7350	Registration of Graphic Character Subrepertoires
DIS 7350.2	Registration of Graphic Character Subrepertoires, Draft Second Edition, 1987
ISO 8859-1	8-Bit Single-Byte Coded Graphic Character Sets - Part 1: Latin Alphabet No. 1
ISO 8859-2	8-Bit Single-Byte Coded Graphic Character Sets - Part 2: Latin Alphabet No. 2
ISO 8859-3	8-Bit Single-Byte Coded Graphic Character Sets - Part 3: Latin Alphabet No. 3
ISO 8859-4	8-Bit Single-Byte Coded Graphic Character Sets - Part 4: Latin Alphabet No. 4
DIS 8859-5.2	8-Bit Single-Byte Coded Graphic Character Sets - Part 5: Latin/Cyrillic Alphabet
ISO 8859-6	8-Bit Single-Byte Coded Graphic Character Sets - Part 6: Latin/Arabic Alphabet
ISO 8859-7	8-Bit Single-Byte Coded Graphic Character Sets - Part 7: Latin/Greek Alphabet
DIS 8859-8	8-Bit Single-Byte Coded Graphic Character Sets - Part 8: Latin/Hebrew Alphabet
DIS 8859-9	8-Bit Single-Byte Coded Graphic Character Sets - Part 9: Latin Alphabet No. 5
DIS 8859-10	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 10: Latin/ Alphabet, June 1991
DIS 9541-1	Font and Character Information Exchange - Part 1: Introduction (second DIS ballot closed 17 November 1990)
DIS 9541-2	Font and Character Information Exchange - Part 2: Registration and Naming Procedures (ballot closed 17 November 1990)
DIS 9541-3	Font and Character Information Exchange - Part 3: Glyph Shape Representation
DIS 9541-4	Font and Character Information Exchange - Part 4: Character Collections
DIS 9541-5	Font and Character Information Exchange - Part 5: Font Attributes and Character Model
DIS 9541-6	Font and Character Information Exchange - Part 6: Font and Character Attribute Subsets and Application
DP 9541-7	Font and Character Information Exchange - Part 7: Font Interchange Format
DIS 10036	Procedure for Registration of Glyph and Glyph Collection Identifiers (ballot closed 17 November 1990)
DP 10646	Multiple Octet Coded Character Set, SC27, November 1989

F. MAN-MACHINE LANGUAGE (MML):

CCITT Z.301	Introduction to the CCITT Man-Machine Language (MML)
CCITT Z.302	The Meta-Language for Describing MML Syntax and Dialogue Procedures
CCITT Z.311	Introduction to Syntax and Dialogue Procedures (MML)
CCITT Z.312	Basic Format Layout (MML)
CCITT Z.314	The Character Set and Basic Elements (MML)

CCITT Z.315	Input (Command) Language Syntax Specification (MML)
CCITT Z.316	Output Language Syntax Specification (MML)
CCITT Z.317	Man-Machine Dialogue Procedures (MML)
CCITT Z.321	Introduction to the Extended MML for Visual Display Terminals
CCITT Z.322	Capabilities of Visual Display Terminals
CCITT Z.323	Man-Machine Interaction
CCITT Z.331	Introduction to the Specification of the Man-Machine Interface
CCITT Z.332	Methodology for the Specification of the Man-Machine Interface - General Working Procedures
CCITT Z.333	Methodology for the Specification of the Man-Machine Interface - Tools and Methods
CCITT Z.341	Glossary of Terms (MML)

G. SOFTWARE DEVELOPMENT AND DOCUMENTATION:

ISO 1538	Programming Languages - ALGOL 60, 1984
ISO 1539	Programming Languages - FORTRAN
DIS 1539.2	Programming Languages - FORTRAN Extended, 1991
ISO 1989	Programming Languages - COBOL
ISO 6160	Programming Languages - PL/1
ISO 6373	Programming Languages - BASIC
ISO 6522	Programming Languages - PL/1 General Purpose Subset
ISO 6592	Guidelines for the Documentation of Computer-Based Application Systems
ISO 7185	Programming Languages - Pascal, revised 1990
DIS 8485	Programming Languages - APL, 1991
ISO 8652	Programming Languages - Ada
ISO 9001-3	Quality Systems - Part 3: Guidelines for the Application of ISO 9001 to the Development, Supply, and Maintenance of Software, November 1990
TR 9294	Guidelines for the Management of Software Documentation, Technical Report Type 3, 1990
ISO 9496.2	Programming Languages - CCITT High Level Language (CHILL)
TR 9547	Programming Language Processors - Test Methods - Guidelines for Their Development and Acceptability, April 1988
ISO 9899	Programming Languages - C, 1990
DTR 10034	Guidelines for the Preparation of Conformity Clauses in Programming Language Standards
PDTR 10182	Binding Techniques for Programming Languages [SC22/WG11 N 754], February 1990
ISO 10206	Object Oriented Extensions to Pascal, 1991
DIS 10279	Programming Languages - Full BASIC, 1991
DIS 10967	Language Compatible Arithmetic Standard (LCAS) [SC22 N 796], Version 2.2A, May 1990 (undergoing public review July 1991)
BSI 91/64912	Ad Hoc Meeting on PCTE, 14 June 1991
BSI 91/64913	Background Information on PCTE Standardization, ECMA, ECMA TC33, April 1991
BSI 91/64914	ECMA PCTE, J. Dawes and H. Davis, ICL Secure Systems, March 1991

BSI 91/64915	Extract of PCTE Standards, ECMA, 28 February 1991
SC22 N 190	Specification for a Set of Common Language-Independent Data Types, working draft 4, September 1990
SC22 N 194R	Specification for a Model for Common Language-Independent Procedure Calling Mechanisms, Version 2, December 1990
SC21 N 5583	Report of Liaison Meeting with SC22/WG11, Amsterdam, September 1990, January 1991
SC21 N 5682	Contribution from WG11, Binding Techniques for Languages, February 1991
CCITT Z.200	CCITT High Level Language (CHILL) [see ISO 9496.2]

H. INFORMATION PROCESSING EQUIPMENT:

DIS 8884	Keyboards for Multiple Latin-Alphabet Languages - Layout and Operation Using Four Levels
ISO 9171-1	130 mm Optical Disk Cartridge, Write Once, for Information Interchange, Part 1: Unrecorded Optical Disk Cartridge, 1990
ISO 9171-2	130 mm Optical Disk Cartridge, Write Once, for Information Interchange, Part 2: Recording Format, 1990
ISO 9660	Volume and File Structure of CD-ROM for Information Exchange
CD 9995-1	Keyboard Layouts for Text and Office Systems, Part 1: General Principles Governing Keyboard Layouts
CD 9995-2	Keyboard Layouts for Text and Office Systems, Part 2: Alphanumeric Section
CD 9995-3	Keyboard Layouts for Text and Office Systems, Part 3: Common Secondary Layout of Alphanumeric Zone of Alphanumeric Section
DP 9995-4	Keyboard Layouts for Text and Office Systems, Part 4: Principles Governing the Placement of Characters and Symbols on Keys
CD 9995-5	Keyboard Layouts for Text and Office Systems, Part 5: Editing Section
CD 9995-6	Keyboard Layouts for Text and Office Systems, Part 6: Functional Section
CD 9995-7	Keyboard Layouts for Text and Office Systems, Part 7: Symbols Used to Represent Functions
DP 10033	Recording of Documents Conforming to ISO 8613 on Flexible Disk Cartridges Conforming to ISO 9293
DIS 10222	Enhanced Small Device Interface, 1991
DIS 10149	Data Interchange on Read-Only 120-mm Optical Data Disks (CD-ROM)
DIS 10994	Data Interchange on 90 mm Flexible Disk Cartridges Using MFM Recording at 31 831 FTPRAD on 80 Tracks on Each Side, June 1991
DIS 11319	8 mm Wide Magnetic Tape Cartridge for Information Interchange -- Helical Scan Recording, June 1991
DIS 11321	3,81 mm Wide Magnetic Tape Cartridge for Information Interchange -- Helical Scan Recording-- Data/Dat Format, June 1991

NUMERICAL LISTING OF ISO STANDARDS AND CCITT RECOMMENDATIONS RELEVANT TO CCISs[1]

I. ISO STANDARDS

ISO 646	Information Processing - ISO 7-Bit Coded Character Set for Information Exchange, July 1983
ISO 1155	Use of Longitudinal Parity to Detect Errors in Information Messages
ISO 1177	Character Structure for Start/Stop and Synchronous Character Oriented Transmission
ISO 1538	Programming Languages - ALGOL 60, 1984
ISO 1539	Programming Languages - FORTRAN, 1980
DIS 1539.2	Programming Languages - FORTRAN Extended, 1991
ISO 1745	Information Processing - Basic Mode Control Procedures for Data Communication Systems, February 1975
ISO 1989	Programming Languages - COBOL, 1978
ISO 2022	Information Processing - ISO 7-Bit and 8-Bit Coded Character Sets - Code Extension Techniques, Third Edition, May 1986
ISO 2110.3◆[2]	Data Communication - 25-Pin DTE/DCE Interface Connector and Pin Assignments, Third Edition, 10 April 1989
ISO 2110 DAM 1	Data Communication - 25-Pin DTE/DCE Interface Connector and Pin Assignments, Amendment 1, Interface Connector and Contact Number Assignments for a DTE/DCE for Data Signalling Rates Above 20 kbit/s, (ballot closed 28 December 1990)
ISO 2111	Data Communication - Basic Mode Control Procedures - Code Independent Information Transfer, Second Edition, February 1985
ISO 2375	Data Processing - Procedures for the Registration of Escape Sequences, November 1985
ISO 2382-9	Data Processing - Vocabulary - Part 9: Data Communications, March 1984
CD 2382-17.3	Data Processing - Vocabulary - Part 17: Databases, third committee draft, 11 February 1991 [SC21 N 1241]
DIS 2382-25	Data Processing - Vocabulary - Part 25: Local Area Networks

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1 Based on data initially provided by OMNICON in September 1988. Revised July 1990 based on *The OMNICON Index of Standards for Distributed Information and Telecommunications*, 1989, OMNICON, Inc., and status of standards papers from ISO/IEC JTC1, ANSI X3, and the British Standards Institution (BSI).

Revised March 1991 based on "Status of OSI (and Related) Standards," in *Computer Communication Review*, January 1991, pp. 111-131.

Two BSI documents (*ISO/IEC JTC1/SC21 Project File*, IST21 N 2525, 30 January 1991; and *Project Overview*, IST21 N 2844, 13 June 1991) were major sources for updating the list of standards.

2 The symbol ◆ is used throughout this Appendix to identify those standards included in the November 1989 (Fifth Edition) *NTIS Transition Strategy*.

DP 2382-26	Data Processing - Vocabulary - Part 26: OSI Architecture, September 1989 [SC21 N 3802]
ISO 2593.3♦	Data Communication - 34-Pin DTE/DCE Interface Connector and Pin Assignments, Third Edition, awaiting publication
ISO 2628	Basic Mode Control Procedures - Complements, June 1973
ISO 2629	Basic Mode Control Procedures - Conversational Information Message Transfer, February 1973
ISO 3307	Information Interchange - Representations of Time of the Day, March, 1975
ISO 3309♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Frame Structure, Third Edition, 1984
DIS 3309.4♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Frame Structure, Draft Fourth Edition (second DIS ballot closed 26 October 1990)
ISO 3309 AD 1♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Frame Structure - Addendum 1: Start/Stop transmission, 12 March 1990
ISO 3309 DAM 2♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Frame Structure - Amendment 2: Extended Transparency Option for Start/Stop Transmission (awaiting DAM ballot)
ISO 3309 PDAM 3	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Frame Structure - Amendment 3: Seven-bit Transparency Option for Start/Stop Transmission (ballot closed 10 March 1991)
ISO 3534	Statistics - Vocabulary and Symbols, 1977
ISO 4031	Information Interchange - Representation of Local Time Differentials, December 1987
ISO 4335	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures, Elements of Procedures, Third Edition, August 1987
DIS 4335.4	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures, Elements of Procedures, Draft Fourth Edition (ballot closed 26 October 1990)
ISO 4335 AD 1♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures, Elements of Procedures - Addendum 1: Asynchronous (Start/Stop) Transmission Operation, 1989
ISO 4335 AD 2♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures, Elements of Procedures - Addendum 2: Enhancement of the XID Function Utility, 1989
ISO 4335 AD 3♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Element of Procedures - Addendum 3: Start/Stop Transmission, 12 March 1990
ISO 4335 DAM 4	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Element of Procedures - Amendment 4: Flow Control Unnumbered Information (FUI), (ballot closed 24 November 1990)
ISO 4335 PDAD 5♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Element of Procedures - Addendum 5: Multi-Selective Reject, 1989
ISO 4873	Information Processing - 8-Bit Code for Information Interchange - Structure and Rules for Implementation, July 1986
ISO 4902.3♦	Data Communication - 37-Pin and 9-Pin DTE/DCE Interface Connectors and Pin Assignments, Third Edition, 1989

ISO 4903.3♦	Data Communication - 15-Pin DTE/DCE Interface Connector and Pin Assignments, Third Edition, 1989
ISO 6093	Information Processing - Representation of Numeric Values in Character Strings for Information Exchange, November 1985
ISO 6160	Programming Languages - PL/1, 1979
ISO 6373	Programming Languages - BASIC
DIS 6429	ISO 7-Bit and 8-Bit Coded Character Sets - Control Functions for Coded Character Sets, May 1987
ISO 6522	Programming Languages - PL/1 General Purpose Subset, 1985
ISO 6523	Data Interchange - Structure for the Identification of Organizations, February 1984
ISO 6592	Information Processing - Guidelines for the Documentation of Computer-Based Application Systems, November 1985
ISO 6936	Information Processing - Conversion Between the Two Coded Character Sets of ISO 646 and ISO 6937-2 and the CCITT International Telegraph Alphabet No. 2 (ITA2), May 1983
DIS 6936.2	Information Processing - Conversion Between the Two Coded Character Sets of ISO 646 and ISO 6937-2 and the CCITT International Telegraph Alphabet No. 2 (ITA2), Draft Second Edition, October 1987
ISO 6937-1	Information Processing - Coded Character Sets for Text Communication - Part 1: General Introduction, November 1983
ISO 6937-2	Information Processing - Coded Character Sets for Text Communication - Part 2: Latin Alphabetic and Non-Alphabetic Graphic Characters, December 1983
ISO 6937-2 DAD 1	Information Processing - Coded Character Sets for Text Communication - Part 2: Latin Alphabetic and Non-Alphabetic Graphic Characters, Addendum 1, September 1987
DIS 6937-3	Information Processing - Coded Character Sets for Text Communication - Part 3: Control Functions for Page-Image Format, March 1988
DIS 6937-7	Information Processing - Coded Character Sets for Text Communication - Part 7: Greek Graphic Characters, April 1987
DIS 6937-8	Information Processing - Coded Character Sets for Text Communication - Part 8: Cyrillic Graphic Characters, April 1987
ISO 7185	Programming Languages - Pascal, 1983, revised 1990
ISO 7350	Text Communication - Registration of Graphic Character Subrepertoires, March 1984
DIS 7350.2	Text Communication - Registration of Graphic Character Subrepertoires, Draft Second Edition, October 1987
TR 7477♦	Data Communication - Arrangement for DTE to DTE Physical Connection Using V.24 and X.24 Interchange Circuits, September 1985
ISO 7478♦	Information Processing Systems - Data Communication - Multilink Procedures, July 1987
ISO 7478/Cor 1	Information Processing Systems - Data Communication - Multilink Procedures, Technical Corrigendum 1, 1 March 1989 [SC21 N 2738, June 1988]
DIS 7480.2	Information Processing - Start-Stop Transmission Signal Quality at DTE/DCE Interfaces, Second Edition (awaiting DIS ballot)
ISO 7498♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 1: General Aspects, October 1984 [SC21 N 3273, December 1988] (CD text for revision incorporating AD 1 is 7498-1 below)

ISO 7498/Cor 1	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 1: General Aspects, Technical Corrigendum 1, 15 December 1988
ISO 7498 AD 1♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 1: General Aspects, Addendum 1: Connectionless-Mode Transmission, July 1987
ISO 7498 PDAD 2♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 1: General Aspects, Addendum 2: Multipeer Data Transmission (MPDT) [SC21 N 3287] (Reassessment Report, SC21 N 3906, September 1989; project suspended in November 1989, SC21 N 4276)
CD 7498-1♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 1: General Aspects, June 1991 [SC21 N 6152] (revised text incorporates AD 1; DIS expected in March 1992, IS in March 1993)
ISO 7498-2♦	Information Processing Systems - Open Systems Interconnection Reference Model - Part 2: Security Architecture, February 1989
ISO 7498-3♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 3: Naming and Addressing, March 1989
ISO 7498-4♦	Information Processing Systems - Open Systems Interconnection - Basic Reference Model - Part 4: Management Framework, November 1989 [SC21 N 3502, 24 April 1989]
ISO 7776♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Description of the X.25 LAPB-Compatible DTE Data Link Procedures, December 1986
ISO 7776/Cor 1	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Description of the X.25 LAPB-Compatible DTE Data Link Procedures, Technical Corrigendum 1, 1 April 1989
ISO 7776/Cor 2	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Description of the X.25 LAPB-Compatible DTE Data Link Procedures, Technical Corrigendum 2, 1 September 1989
ISO 7776 DAM 1	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Description of the X.25 LAPB-Compatible DTE Data Link Procedures, Amendment 1: PICS Proforma, (awaiting DAM ballot)
ISO 7809♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Consolidation of Classes of Procedures, February 1984
DIS 7809.2	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Consolidation of Classes of Procedures, Draft Second Edition (second DIS ballot closed 26 October 1990)
ISO 7809 AD 1♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Consolidation of Classes of Procedures - Addendum 1 (no title; contains UI Command/Responses), June 1986
ISO 7809 AD 2♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Consolidation of Classes of Procedures, Addendum 2: Descriptions of Optional Functions, June 1987
ISO 7809 AD 3♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Classes of Procedures - Addendum 3: Start/Stop Transmission, 12 March 1990
ISO 7809 PDAD 4♦	Information Processing Systems - Data Communication - High Level Data Link Control (HDLC) Procedures - Consolidation of Classes of Procedures - Addendum 4: List of Standard Data Link Layer Protocols That Utilize HDLC Classes of Procedures, March 1988 (DP) [see DTR 10171, March 1989]

ISO 7809 DAM 5	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Classes of Procedures - Amendment 5: Connectionless Class of Procedure, (awaiting DAM ballot)
ISO 7809 DAM 6	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Classes of Procedures - Amendment 6: Extended Transparency Option, (awaiting DAM ballot)
ISO 7809 DAM 7	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Classes of Procedures - Amendment 7: Multi-Selective Reject, (ballot closed 24 November 1990)
ISO 7809 PDAM 9	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - Classes of Procedures - Amendment 9: Seven-bit Transparency Option for Start/Stop Transmission (ballot closed 10 March 1991)
DP 7826	Representation of Data Elements
ISO 7942	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Functional Description, August 1985
ISO 7942 DAD 1	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Functional Description, Addendum 1: Audit Trail Metafile, 1989
ISO 8072♦	Information Processing Systems - Open Systems Interconnection - Transport Service Definition, 15 June 1986
ISO 8072 AD 1♦	Information Processing Systems - Open Systems Interconnection - Transport Service Definition - Addendum 1: Connectionless-Mode Transmission, 15 July 1986
ISO 8073♦	Information Processing Systems - Open Systems Interconnection - Connection Oriented Transport Protocol Specification, 15 July 1986
ISO 8073 AD 1♦	Information Processing Systems - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Addendum 1: Network Connection Management Subprotocol, June 1988
ISO 8073 AD 2♦	Information Processing Systems - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Addendum 2: Class Four Operation Over Connectionless Network Service, July 1987
ISO 8073 DAM 3♦	Information Processing System - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Amendment 3: Protocol Implementation Conformance Statement Proforma (ballot closed 11 April 1991)
ISO 8073 DAM 4♦	Information Processing System - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Amendment 4: Transport Protocol Enhancements
ISO 8073/Cor 1♦	Information Processing System - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Technical Corrigendum 1, 15 January 1990
ISO 8073/Cor 2♦	Information Processing System - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Technical Corrigendum 2, 1 May 1990
ISO 8073/Cor 3♦	Information Processing System - Open Systems Interconnection - Connection Oriented Transport Protocol Specification - Technical Corrigendum 3, 1 June 1990
ISO 8208	Information Processing Systems - Data Communications - X.25 Packet Level Protocol (PLP) for Data Terminal Equipment, Second edition published March 1990
ISO 8208 AM 1	Information Processing Systems - X.25 Packet Level Protocol (PLP) for Data Terminal Equipment - Amendment 1: Alternative Logical Channel Identifier Assignment, 15 September 1990
ISO 8208 PDAD 2♦	Information Processing Systems - X.25 Packet Level Protocol (PLP) for Data Terminal Equipment - Addendum 2 - Extensions for Private and Switched Use (project cancelled; addendum WITHDRAWN, 1989)

ISO 8208 AM 3	Information Processing Systems - Data Communications - X.25 Packet Level Protocol (PLP) for Data Terminal Equipment - Amendment 3: Static Conformance Requirements, 12 October 1990
ISO 8211	Information Processing - Specification for a Data Descriptive File for Information Interchange, December 1985 (revision in progress, July 1991)
WD 8211.2	Information Processing - Specification for a Data Descriptive File for Information Interchange, July 1991 [SC21 N 6128] (CD text expected December 1991, DIS in August 1992, IS in March 1993
ISO 8326♦	Information Processing Systems - Open Systems Interconnection - Connection Oriented Session Service Definition, 15 August 1987; revised to incorporate AD 1, AD 2, and AD 3 (draft 19 April 1990, SC21 N 4657); Technical Corrigendum, 30 April 1990 [SC21 N 4637 and 4638]
ISO 8326 AD 1♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Service Definition - Addendum 1: Session Symmetric Synchronization for the Session Service [SC21 N 3507, October 1989]; incorporated into ISO 8326, April 1990
ISO 8326 AD 2♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Service Definition - Addendum 2: Incorporation of Unlimited User Data, [SC21 N 2495, 27 June 1988]; incorporated into ISO 8326, April 1990
ISO 8326 AD 3♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Service Definition - Addendum 3: Connectionless-Mode Session Service [SC21 N 3462, August 1989]; incorporated into ISO 8326, April 1990
ISO 8326 DAM 4.2	Information Technology - Open Systems Interconnection - Basic Connection Oriented Session Service Definition - Addendum 4: Additional Resynchronization Functionality, 9 May 1991 [SC21 N 5921]
ISO 8327♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification, 15 August 1987; revised to incorporate AD 1 and AD 2 (draft 19 April 1990, SC21 N 4656); Technical Corrigendum, 30 April 1990 [SC21 N 4663-4666]
ISO 8327 AD 1♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification - Addendum 1: Session Symmetric Synchronization for the Session Protocol [SC21 N 3508, October 1989]; incorporated into ISO 8327, April 1990
ISO 8327 AD 2♦	Information Processing Systems - Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification - Addendum 2: Incorporation of Unlimited User Data [SC21 N 2494, 27 June 1988]; incorporated into ISO 8327, April 1990
ISO 8327 PDAM 3.2	Information Technology - Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification - Amendment 3 to Incorporate Additional Synchronization Functionality, 9 May 1991 [SC21 N 5922]
CD 8327-2♦	Information Technology - Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification - Part 2: Protocol Implementation Conformance Statement (PICS) Proforma, July 1990 [SC21 N 5022], 10 January 1990 (second draft; DIS text expected in November 1991, IS in November 1992)
ISO 8348♦	Information Processing Systems - Data Communications - Network Service Definition, 15 April 1987
ISO 8348 AD 1♦	Information Processing Systems - Data Communications - Network Service Definition - Addendum 1: Connectionless-Mode Transmission, 15 April 1987
ISO 8348 AD 2♦	Information Processing Systems - Data Communications - Network Service Definition - Addendum 2: Network Layer Addressing, 1 June 1988

ISO 8348 AD 3♦	Information Processing Systems - Data Communications - Network Service Definition - Addendum 3: Additional Features of the Network Service, 15 October 1988
ISO 8348 PDAM 4	Information Processing Systems - Data Communications - Network Service Definition - Addendum 4: Removal of the Preferred Decimal Encoding of the NSAP Address (awaiting PDAM ballot)
ISO 8372	Information Processing - Modes of Operation for a 64-bit Block Cipher Algorithm, 1987
ISO 8471♦	Data Communication - High-Level Data Link Control (HDLC) Balanced Classes of Procedures - Data-Link Layer Address Resolution/ Negotiation in Switched Environments, April 1987
ISO 8473♦	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS), January 1988
ISO 8473 PDAD 1♦	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS) - Addendum 1: Provision of Underlying Service Assumed by ISO 8473 Over Point-to-Point Subnetworks Which Provide the OSI Data Link Service, July 1987 (DP)
ISO 8473 PDAD 2♦	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS) - Addendum 2: Estelle Formal Description of ISO 8473, Revised Edition, April 1988 (to be reballoted as a DTR)
ISO 8473 AD 3♦	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS) - Amendment x:PICS Proforma (new work item)
ISO 8473 PDAM x	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS) - Addendum 3: Provision of the Underlying Service Assumed by ISO 8473 over Subnetworks Which Provide the OSI Data Link Service, 15 February 1989
ISO 8473 PDAM y	Information Processing Systems - Data Communications - Protocol for Providing the Connectionless-Mode Network Service (CLNS) - Amendment y: Provision of the Underlying Service Assumed by ISO 8473 over ISDN Circuit-Switched B-channels (new work item)
ISO 8480♦	Information Processing - Data Communication - DTE/DCE Interface Back-up Control Operation Using the 25-Pole Connector, November 1987
ISO 8481♦	Data Communication - DTE to DTE Physical Connection Using X.24 Interchange Circuits with DTE Providing Timing, September 1986
ISO 8482♦	Information Processing Systems - Data Communication - Twisted Pair Multipoint Interconnections, November 1987
DIS 8485	Programming Languages - APL, 1991
DIS 8505	Information Processing Systems - Text Communication - Functional Description and Service Specification for Message Oriented Text Interchange Systems (MOTIS), February 1986 (WITHDRAWN, superceded by ISO 10021)
TR 8509♦	Information Processing Systems - Open Systems Interconnection - Service Conventions, September 1987
ISO 8571-1♦	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 1: General Introduction, Revised Edition, October 1988; Technical Corrigendum 1, February 1990 [SC21 N 4371]
ISO 8571-1 DAM 1♦	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 1: General Introduction, Amendment 1: Filestore Management, July 1990 [SC21 N 4994, October 1990] July 1991

ISO 8571-1 AM 2♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 1: General Introduction, Amendment 2: Overlapped Access, 27 June 1991 [SC21 N 5872] (DIS balloting ends 27 December 1991; IS expected June 1992)

ISO 8571-1 PDAM 3 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 1: General Introduction, Amendment 3: Service Enhancement, July 1991 [SC21 N 6218] (DIS text expected in June 1992, IS in June 1993)

ISO 8571-1 WDAM 4 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 1: General Introduction, Amendment 4: Enhancement to FTAM Security Services (CD text expected October 1992)

ISO 8571-2♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 2: Virtual Filestore Definition, Revised Edition, October 1988; Technical Corrigendum 1, February 1990 [SC21 N 4372]

ISO 8571-2 AM 1♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 2: Virtual Filestore Definition, Amendment 1: Filestore Management, July 1990 [SC21 N 4995, October 1990] July 1991

ISO 8571-2 DAM 2♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 2: Virtual Filestore Definition, Addendum 2: Overlapped Access, 13 April 1990, 27 June 1991 [SC21 N 5873] (DIS balloting ends 27 December 1991; IS expected June 1992)

ISO 8571-2 PDAM 3 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 2: Virtual Filestore Definition, Amendment 3: Service Enhancement, July 1991 [SC21 N 6219] (DIS text expected in June 1992, IS in June 1993)

ISO 8571-2 WDAM 4 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 2: Virtual Filestore Definition, Amendment 4: Enhancement to FTAM Security Services (CD text expected October 1992)

ISO 8571-3♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 3: File Service Definition, Revised Edition, October 1988; Technical Corrigendum 1, February 1990 [SC21 N 4373]

ISO 8571-3 AM 1♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 3: File Service Definition, Amendment 1: Filestore Management, July 1990 [SC21 N 4996, October 1990] July 1991

ISO 8571-3 DAM 2♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 3: File Service Definition, Addendum 2: Overlapped Access, 27 June 1991 [SC21 N 5874] (DIS balloting ends 27 December 1991; IS expected June 1992)

ISO 8571-3 PDAM 3 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 3: File Service Definition, Amendment 3: Service Enhancement, July 1991 [SC21 N 6220] (DIS text expected in June 1992, IS in June 1993)

ISO 8571-3 WDAM 4 Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 3: File Service Definition, Amendment 4: Enhancement to FTAM Security Services (CD text expected October 1992)

ISO 8571-4♦ Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 4: File Protocol Specification, Revised Edition, October 1988; Technical Corrigendum 1, February 1990 [SC21 N 4374]

ISO 8571-4 AM 1♦	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 4: File Protocol Specification, Amendment 1: Filestore Management, July 1990 [SC21 N 4997, October 1990] July 1991
ISO 8571-4 DAM 2♦	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 4: File Protocol Specification, Addendum 2: Overlapped Access, 27 June 1991 [SC21 N 5875] (DIS balloting ends 27 December 1991; IS expected June 1992)
ISO 8571-4 PDAM 3	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 4: File Protocol Specification, Amendment 3: Service Enhancement, July 1991 [SC21 N 6221] (DIS text expected in June 1992, IS in June 1993)
ISO 8571-4 WDAM 4	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 4: File Protocol Specification, Amendment 4: Enhancement to FTAM Security Services (CD text expected in October 1992)
ISO 8571-5:1990(E)	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 5: Protocol Implementation Conformance Statement Proforma, July 1990 [SC21 N 3467, April 1989] [SC21 N 5493, November 1990]
ISO 8571-5 WDAM 1	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 5: Protocol Implementation Conformance Statement Proforma, Amendment 1: Filestore Management, July 1991 [SC21 N 6274]
ISO 8571-5 WDAM 2	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 5: Protocol Implementation Conformance Statement Proforma, Amendment 2: Overlapped Access, June 1991 [SC21 N 6274]
ISO 8571-5 WDAM 3	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 5: Protocol Implementation Conformance Statement Proforma, Amendment 3: Service Enhancement, June 1991 [SC21 N 6223] (CD text expected October 1992, DIS in June 1993, IS in June 1994)
ISO 8571-5 WDAM 4	Information Processing Systems - Open Systems Interconnection - File Transfer, Access and Management (FTAM) - Part 5: Protocol Implementation Conformance Statement Proforma, Amendment 4: Enhancement to FTAM Security Services (CD text expected October 1992)
DIS 8601	Data Elements and Interchange Formats - Information Exchange - Representation of Dates and Times, June 1986
ISO 8602♦	Information Processing Systems - Open Systems Interconnection - Protocol for Providing the Connectionless-Mode Transport Service, 15 December 1987
ISO 8602 DAM 1	Information Processing Systems - Open Systems Interconnection - Protocol for Providing the Connectionless-Mode Transport Service, Amendment 1: PICS Proforma
ISO 8613-1♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 1: Introduction and General Principles, July 1988 [CCITT T.411]
ISO 8613-1 DAM 1	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 1: Introduction and General Principles, Amendment 1: Document Application Profile Proforma and Notation (ballot closed 1 July 1990)

ISO 8613-1 DAM 2	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 1: Introduction and General Principles, Amendment 2: Conformance Testing Methodology
ISO 8613-2♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 2: Document Structures, July 1988 [CCITT T.412]
ISO 8613-2 PDAD 1	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 2: Document Structures - Addendum 1: Formal Specification of ODA Document Structures, June 1988
ISO 8613-3♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 3: Document Processing Reference Model, September 1986 (WITHDRAWN)
ISO 8613-4♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 4: Document Profile, July 1988 [CCITT T.414]
ISO 8613-5♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 5: Office Document Interchange Format (ODIF), July 1988 [CCITT T.415]
ISO 8613-6♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 6: Character Content Architectures, July 1988 [CCITT T.416]
ISO 8613-7♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 7: Raster Graphics Content Architectures, July 1988 [CCITT T.417]
ISO 8613-8♦	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 8: Geometric Graphics Content Architectures, July 1988 [CCITT T.418]
ISO 8613-9	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 9: Audio Content Architectures
ISO 8613-10	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 10: Formal Specifications
ISO 8613-10 DAM 1	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 10: Formal Specifications, Amendment 1: Formal Specification of the Document Profile (ballot closed 1 March 1991)
ISO 8613-10 DAM 2	Information Processing - Text and Office Systems - Office Document Architecture (ODA) and Interchange Format - Part 10: Formal Specifications, Amendment 2: Formal Specification of the Raster Graphics Content Architectures (ballot closed 1 March 1991)
ISO 8632-1	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 1: Functional Specification, 1 August 1987
ISO 8632-1 DAD 1	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 1: Functional Specification, Addendum 1: Audit Trail Metafile, 1989
ISO 8632-1 PDAD 2	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 1: Functional Specification, Addendum 2: 3D Static Picture Capture Metafile, 1989
ISO 8632-2	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 2: Character Encoding, 1 August 1987

ISO 8632-3	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 3: Binary Encoding, 1 August 1987
ISO 8632-4	Information Processing Systems - Computer Graphics - Metafile (CGM) for the Storage and Transfer of Picture Description Information - Part 4: Clear Text Encoding, 1 August 1987
ISO 8648♦	Information Processing Systems - Open Systems Interconnection - Internal Organization of the Network Layer, 15 February 1988
ISO 8648/Cor 1	Information Processing Systems - Open Systems Interconnection - Internal Organization of the Network Layer, Technical Corrigendum 1 (awaiting publication)
ISO 8649♦	Information Processing Systems - Open Systems Interconnection - Service Definition for the Association Control Service Element (ACSE), 15 December 1988 [SC21 N 2326, January 1988] (defect report ballots SC21 N 4447-49, February 1990)
ISO 8649 AM 1♦	Information Processing Systems - Open Systems Interconnection - Service Definition for the Association Control Service Element (ACSE) - Amendment 1: Peer-Entity Authentication During Association Establishment, November 1990 [SC21 N 5462]
ISO 8649 AD 2♦	Information Processing Systems - Open Systems Interconnection - Service Definition for the Association Control Service Element (ACSE) - Connectionless-Mode ACSE Service, 1 June 1990 [SC21 N 4937]
ISO 8649 WDAD 3♦	Information Processing Systems - Open Systems Interconnection - Service Definition for the Association Control Service Element (ACSE) - Application Context Management, 1989 (formal WD text expected June 1992, Cd in June 1993, DIS in June 1994, IS in June 1995)
ISO 8650♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element (ACSE), 15 December 1988; Technical Corrigendum, 1 June 1990; Amendment, February 1990, SC21 N 4286]
ISO 8650 AM 1♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element (ACSE) - Amendment 1: Peer-Entity Authentication During Association Establishment, November 1990 [SC21 N 5463]
ISO 8650 WDAM 3♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element (ACSE) - Amendment 2: Application Context Management (CD expected October 1991, DIS in May 1992, IS in May 1993)
ISO 8650 WDAD 4♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element (ACSE) - Addendum 4: Application Entity Titles, 1989
DIS 8650-2♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Association Control Service Element (ACSE) - Part 2: PICS Proforma, July 1990 [SC21 N 5024] (document will not be balloted until session PICS is at DIS status; IS status expected November 1992)
ISO 8651-1	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Language Bindings - Part 1: FORTRAN, October 1988
ISO 8651-2	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Language Bindings - Part 2: Pascal, October 1988
ISO 8651-3	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Language Bindings - Part 3: Ada, October 1988

DIS 8651-4	Information Processing Systems - Computer Graphics - Graphical Kernel System (GKS) Language Bindings - Part 4: C, (ballot closed 2 December 1990)
ISO 8652	Programming Languages - Ada
ISO 8790	Information Processing Systems - Computer System Configuration Diagram Symbols and Conventions, September 1987
DP 8800-1	Information Processing Systems - IRDS - Part 1: Command Language and Panel Interface, April 1987 [SC21 N 1789] (projected suspended until the IRDS services interface reaches DIS status; the command language and panel interface are expected to be split into separate standards)
ISO 8802-1♦	Information Processing Systems - Local Area Networks - Part 1: General Introduction, 1989
DIS 8802-1.2	Information Processing Systems - Local Area Networks - Part 1: General Introduction with System Load Protocol (ballot closed 7 March 1991)
ISO 8802-2.2	Information Processing Systems - Local Area Networks - Part 2: Logical Link Control, Second Edition, 16 March 1990
ISO 8802-2.2 DAM 1	Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - Amendment 1: Flow Control Techniques for Bridged Local Area Networks, (ballot closed 19 November 1988)
ISO 8802-2.2 DAM 2	Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - Amendment 2: Type 3 Operation-Acknowledge Connectionless Service, (ballot closed 2 May 1990)
ISO 8802-2.2 PDAM 3	Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - Amendment 3: PICS Proforma, (ballot closed 10 September 1990)
ISO 8802-2.2 DAM 4	Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - Amendment 4: Editorial Changes and Technical Corrections, ballot closed 24 November 1990)
ISO 8802-3♦	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications, November 1987
ISO 8802-3 DAM 1	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 1: Physical Signalling, Medium Attachment, and Baseband Medium Specifications for Type 1BASE5, 1989
ISO 8802-3 DAM 2	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 2: Repeater Set and Repeater Unit Specification for Use with 10BASE5 and 10BASE2 Networks, July 1987
ISO 8802-3 DAM 3	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 3: Broadband Medium Attachment Unit and Broadband Medium Specifications, Type 10BROAD36, (ballot closed 28 October 1990)
ISO 8802-3 DAM 4♦	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 4: Broadband Medium Attachment Unit and Broadband Medium Specifications, Type 1BASE5 (StarLAN), (ballot closed January 1990)
ISO 8802-3 DAM 5♦	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 5: Medium Attachment Unit and Baseband Medium Specification for a Vendor-Independent Fibre Optic Inter-Repeater Link (FOIRL), 1989

ISO 8802-3 DAM 6	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 6: Summary of IEEE 802.3 First Maintenance Ballot (awaiting DAM ballot)
ISO 8802-3 PDAM 7	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 7: LAN Layer Management (awaiting PDAM ballot)
ISO 8802-3 PDAM 9	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) - Amendment 9: Physical Medium, Medium Attachment, and Baseband Medium Specifications, Type 10baseT (new work item)
ISO 8802-4.2♦	Information Processing Systems - Local Area Networks - Part 4: Token-Passing Bus Access Method and Physical Layer Specifications, Second Edition, November 1987
ISO 8802-5♦	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification, February 1987
DIS 8802-5.2	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification, Revised Edition (second DIS ballot on consolidated document containing Part 5 and its first 3 addenda closed 1 September 1990)
ISO 8802-5 PDAM 1	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification - Amendment 1: 4 and 16 Mbit/s Specification, June 1989
ISO 8802-5 PDAM 2	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification - Amendment 2: MAC Sublayer Enhancement, July 1989
ISO 8802-5 PDAM 3	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification - Amendment 3: Management Entity Specification, July 1989
ISO 8802-5 DAM 4	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification - Amendment 4: Source Routing MAC Bridge, (awaiting DAM ballot)
ISO 8802-5 DAM 5	Information Processing Systems - Local Area Networks - Part 5: Token Ring Access Method and Physical Layer Specification - Amendment 5: PICS Proforma, (awaiting DAM ballot)
DIS 8802-6♦	Information Processing Systems - Local Area Networks - Part 6: Distributed Queue Dual Bus (DQDB) Media Access Control (MAC), 1989
ISO 8802-7♦	Information Processing Systems - Local Area Networks - Part 7: Slotted Ring Access Method and Physical Layer Specification, 1989
DIS 8802-9♦	Information Processing Systems - Local Area Networks - Part 9: Integrated Voice and Data (IVD) LAN
ISO 8805	Information Processing Systems - Computer Graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Functional Description, October 1988
ISO 8805 WDAD 1	Working Draft for Information Processing Systems - Computer Graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Addendum 1: Name Set Addendum, April 1987 (WD)
DIS 8806-1	Information Processing Systems - Computer Graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Language Bindings - Part 1: FORTRAN, November 1988
DIS 8806-3	Information Processing Systems - Computer Graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Language Bindings - Part 3: Ada, 1989

DIS 8806-4 Information Processing Systems - Computer Graphics - Graphical Kernel System for Three Dimensions (GKS-3D) Language Bindings - Part 4: C, (ballot closed 2 December 1990)

ISO 8807♦ LOTOS - A Formal Description Technique Based on the Temporal Ordering of Observational Behaviour, 15 February 1989

ISO 8807 DAM 1 LOTOS - A Formal Description Technique Based on the Temporal Ordering of Observational Behavior, Addendum 1, Graphical Representation of LOTOS (G-LOTOS), July 1991 [SC21 N 4228, December 1989] (IS expected December 1992)

ISO 8822♦ Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Service Definition, 15 August 1988 [SC21 N 2335, April 1988; defect report SC21 N 3761, August 1989]

ISO 8822 AD 1♦ Information Processing Systems - Open Systems Interconnection - Addendum 1: Connectionless-Mode Presentation Service, 1 June 1990 [SC21 N 4933]

ISO 8822 PDAM 2♦ Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Service Definition, Amendment 2: Support of Session Symmetric Synchronization Service, February 1990 (DIS text expected December 1992, IS in October 1993)

ISO 8822 PDAM 3.2 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Service Definition, Amendment 3: Unlimited User Data, July 1991 [SC21 N 5065, July 1990] (DIS text expected June 1992, IS text in June 1993)

ISO 8822 PDAM 4 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Service Definition, Amendment 4: Abstract Syntax Registration, 20 July 1990 [SC21 N 5067] (DIS text expected June 1991, IS text in June 1992)

ISO 8822 PDAM 5 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Service Definition, Amendment 5: Delivery of additional session synchronizaton functionality to the presentation service user [SC21 N 5411], October 1990 (DIS text expected in 1991, IS in March 1992)

ISO 8822 WDAM 6 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Service Definition, Amendment 6: Confidentiality and Integrity, July 1990 [SC21 N 5054] (CD text expected December 1991, DIS in June 1992, IS in June 1993)

ISO 8823♦ Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, 15 August 1988 [SC21 N 2336, April 1988] (defect reports SC21 N 3751-3760, August 1989)

ISO 8823 DAD 1 Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 1: Presentation protocol implementation conformance statement (PICS) proforma, [renumbered as DIS 8823-2, see below]

ISO 8823 WDAM 2♦ Information Processing Systems - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 2: Support of Session Symmetric Synchronization Service, February 1990 (CD text expected September 1990)

ISO 8823 PDAM 3 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 3: Transfer Syntax Registration, 20 July 1990 [SC21 N 5068] (DIS text expected August 1991, IS text in June 1992)

ISO 8823 PDAM 4 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 4: Unlimited User Data, July 1991 [SC21 N 5066, July 1990]

ISO 8823 PDAM 5 Information Technology - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 5: Additional Resynchronization

	Functionality, October 1990 [SC21 N 5412] (DIS text expected in 1991, IS in March 1992)
ISO 8823 WDAM 6	Information Technology - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification, Amendment 6: Confidentiality and Integrity, July 1990 [SC21 N 3164, July 1989] (PDAM expected June 1991)
DIS 8823-2◆	Information Technology - Open Systems Interconnection - Connection Oriented Presentation Protocol Specification - Part 2: Presentation Protocol Implementation Conformance Statement (PICS) Proforma, June 1990 [SC21 N 5258] (IS text expected November 1992)
ISO 8824◆	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1), December 1987; Revised Edition incorporates AM 1, April 1990 [SC21 N 4720]
ISO 8824 AD 1	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1) - Addendum 1: ASN.1 Extensions, June 1988 [SC21 N 2341]; incorporated in Revised Edition of ISO 8824, April 1990
ISO 8824 PDAM 2	Amendments to ISO 8824 to Give ISO 8824 Part 1: Basic ASN.1, 8 July 1991 [SC21 N 6294] (balloting ends 29 October 1991; DIS text expected December 1991, IS in October 1992)
WD 8824-1	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1) - Part 1: Basic ASN.1, 8 July 1991 [SC21 N 6294]
CD 8824-2	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1) - Part 2: Information Object Specification, 8 July 1991 [SC21 N 6289]
CD 8824-3	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1) - Part 3: Constraint Specification, 8 July 1991 [SC21 N 6290]
CD 8824-4	Information Technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1) - Part 3: Parameterisation of ASN.1 Specifications, 8 July 1991 [SC21 N 6291]
ISO 8825◆	Information Technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1), November 1987; Revised Edition incorporates AM 1, April 1990 [SC21 N 4721]
ISO 8825 AD 1	Information Technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Addendum 1: ASN.1 Extensions, June 1988 [SC21 N 2342]; incorporated in Revised Edition of ISO 8825, April 1990
ISO 8825 PDAM 2	Amendments to ISO 8825 to Give ISO 8825 Part 1: Basic Encoding Rules, 8 July 1991 [SC21 N 6295] (balloting ends 29 October 1991; DIS text expected December 1991, IS in October 1992)
WD 8825-1	Information Technology - Open Systems Interconnection - Specification of Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 1: Basic Encoding Rules, 8 July 1991 [SC21 N 6295]
CD 8825-2	Information Technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 2: Packed Encoding Rules, 8 July 1991 [SC21 N 6292]
CD 8825-3	Information Technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) - Part 3: Distinguished Encoding Rules, 8 July 1991 [SC21 N 6293]
WD 8825-4	Conformance Test Suite for the Presentation Protocol - Part 4: Test Suite Structure and Test Purposes for ASN.1 Encodings, SC21/WG6, July 1990 [SC21 N 5019]

	(CD text expected in February 1991, DIS text in November 1991, IS text in November 1992)
ISO 8831♦	Information Processing Systems - Open Systems Interconnection - Job Transfer and Manipulation (JTM) Concepts and Service, June 1989 [SC21 N 2613, January 1989]
DIS 8831.2	Information Processing Systems - Open Systems Interconnection - Job Transfer and Manipulation (JTM) Concepts and Service, June 1991 (IS second edition text expected November 1991)
ISO 8832♦	Information Processing Systems - Open Systems Interconnection - Specification of the Basic Class Protocol for Job Transfer and Manipulation (JTM), June 1989 [SC21 N 3633, January 1989]; draft Revised Edition of 12 December 1989 incorporates AD 1 [SC21 N 4183]
ISO 8832 AM 1♦	Information Processing Systems - Open Systems Interconnection - Specification of the Basic Class Protocol for Job Transfer and Manipulation, Addendum 1: JTM Full Protocol Specification, 28 May 1990 [SC21 N 5225, text with amendment incorporated; and SC21 N 5224, amendment alone] (approved 12 June 1991; IS text expected November 1991)
ISO 8859-1	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 1: Latin Alphabet No. 1, February 1987
ISO 8859-2	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 2: Latin Alphabet No. 2, February 1987
ISO 8859-3	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 3: Latin Alphabet No. 3, April 1988
ISO 8859-4	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 4: Latin Alphabet No. 4, April 1988
DIS 8859-5.2	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 5: Latin/Cyrillic Alphabet, December 1987
ISO 8859-6	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 6: Latin/Arabic Alphabet, August 1987
ISO 8859-7	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 7: Latin/Greek Alphabet, November 1987
DIS 8859-8	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 8: Latin/Hebrew Alphabet, July 1987
DIS 8859-9	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 9: Latin Alphabet No. 5, August 1988
DIS 8859-10	Information Processing - 8-Bit Single-Byte Coded Graphic Character Sets - Part 10: Latin/ Alphabet, June 21, 1991
ISO 8877♦	Information Processing Systems - Interface Connector and Contact Assignments for ISDN Basic Access Interface Located at Reference Points S and T, August 1987
ISO 8877 DAM 1	Information Processing Systems - Interface Connector and Contract Assignments for ISDN Basic Access Located at Reference Points S and T - Amendment 1: Standard ISDN Basic Access TE Connecting Cord, (awaiting second DAM ballot)
ISO 8878♦	Information Processing Systems - Data Communications - Use of X.25 to Provide the OSI Connection-Mode Network Service (CONS), September 1987 (X.223)
ISO 8878 AD 1	Information Processing Systems - Data Communications - Use of X.25 to Provide the OSI Connection-Mode Network Service (CONS), Addendum 1: Protection and Priority, 15 June 1990
ISO 8878 AD 2	Information Processing Systems - Data Communications - Use of X.25 to Provide the OSI Connection-Mode Network Service (CONS), Addendum 2: Use of an X.25 PVC to Provide the OSI CONS, 15 June 1990

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ISO 8878 PDAM 4	Information Processing Systems - Data Communications - Use of X.25 to Provide the OSI Connection-Mode Network Service (CONS), Amendment 4: PICS Proforma, (awaiting second PDAM ballot)
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ISO 8879	Information Processing - Text and Office Systems - Standard Generalized Markup Language (SGML), 15 October 1986
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ISO 8880-2 DAM 1	Information Processing Systems - Protocol Combination to Provide and Support the OSI Network Service - Part 2: Provision and Support of the Connection-Mode Network Services, Amendment 1: Addition of the ISDN Environment (awaiting DAM ballot)
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DIS 8882-2♦	Information Processing Systems - X.25-DTE Conformance Testing - Part 2: Data Link Layer Conformance Test Suite
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DIS 8883	Information Processing Systems - Text Communication - Message Oriented Text Interchange System, Message Transfer Sublayer, Message Interchange Service and Message Transfer Protocol, February 1986 [WITHDRAWN, superceded by ISO 10021-6]

DIS 8884	Information Processing - Text and Office Systems - Keyboards for Multiple Latin-Alphabet Languages - Layout and Operation Using Four Levels, October 1986
ISO 8885♦	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - General Purpose XID Frame Information Field Content and Format, August 1987
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ISO 8885 AD 2	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - General Purpose XID Frame Information Field Content and Format - Addendum 2: Start/Stop Transmission, 12 March 1990
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ISO 8885 DAM 4	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - General Purpose XID Frame Information Field Content and Format - Amendment 4: Extended Transparency Option, (awaiting DAM ballot)
ISO 8885 DAM 5	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - General Purpose XID Frame Information Field Content and Format - Amendment 5: Multi-Selective Reject, (ballot closed 17 November 1990)
ISO 8885 PDAM 6	Information Processing Systems - Data Communication - High-Level Data Link Control (HDLC) Procedures - General Purpose XID Frame Information Field Content and Format - Amendment 6: Seven-bit Transparency Option for Start/Stop Transmission (ballot closed 10 March 1991)
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ISO 9040 AD 1♦	Information Processing Systems - Open Systems Interconnection - Virtual Terminal (VT) Service - Addendum 1: Extended Facility Set, August 1988 [SC21 N 3006]; incorporated into 1990 Revised Edition of ISO 9040
ISO 9040 AM 2♦	Information Processing Systems - Open Systems Interconnection - Virtual Terminal (VT) Service - Amendment 2: Additional Functional Units Service Specification, May 1990 [SC21 N 5030] (approved 12 June 1991; IS text expected late 1991)
ISO 9041-1♦	Information Processing Systems - Open Systems Interconnection - Virtual Terminal (VT) Protocol - Basic Class, Revised Edition, April 1990 [SC21 N 4719]; 1990 Revised Edition incorporates AD 1

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DIS 9065	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) User Agent Sublayer - Interpersonal Messaging User Agent - Message Interchange Formats and Protocols, February 1986 [WITHDRAWN, superceded by ISO 10021]
ISO 9066-1.2♦	Information Processing Systems - Text Communication - Reliable Transfer (RT) - Part 1: Model and Service Definition, Second Edition, September 1989 [SC21 N 3883] (CCITT X.218)
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ISO 9171-1	Information Technology: 130 mm Optical Disk Cartridge, Write Once, for Information Interchange, Part 1: Unrecorded Optical Disk Cartridge, 1990
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DIS 9241-4	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 4: Keyboard Requirements
CD 9241-5	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 5: Workstation Layout and Postural Requirements
CD 9241-6	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 6: Environmental Requirements
CD 9241-7	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 7: Display Requirements with Reflections
CD 9241-8	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 8: Requirements for Displayed Colors
CD 9241-9	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 9: Requirements for Non-Keyboard Input Devices
WD 9241-10	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 10: Dialogue Principles
CD 9241-11	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 11: Usability Statements
CD 9241-12	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 12: Presentation of Information
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CD 9241-14	Ergonomic Requirements for Office Work with Visual Display Terminals, Part 14: Menu Dialogues
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DIS 9541-2	Information Processing Systems - Font and Character Information Exchange - Part 2: Registration and Naming Procedures, (second DIS ballot closed 17 November 1990)
DIS 9541-3	Information Processing Systems - Font and Character Information Exchange - Part 3: Character Identification Method, December 1987
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ISO 9543♦	Information Processing Systems - Information Exchange Between Systems - Synchronous Transmission Signal Quality at DTE/DCE Interfaces, May 1989
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ISO 9545 WDAM 2	Information Processing Systems - Open Systems Interconnection - Application Layer Structure (ALS), Amendment: Connectionless Mode Transmission, June 1988 [SC21 N 2470] (PDAM expected late 1991)
TR 9547	Programming Language Processors - Test Methods - Guidelines for Their Development and Acceptability, April 1988
ISO 9548♦	Information Processing Systems - Open Systems Interconnection - Session Connectionless Protocol to Provide the Connectionless-Mode Session Service, August 1989 [SC21 N 3460]
CD 9548-2.2	Information Processing Systems - Open Systems Interconnection - Session Connectionless Protocol to Provide the Connectionless-Mode Session Service - Part 2: PICS Proforma, 13 May 1991 [SC21 N 5992] (second CD ballot closes 13 September 1991; DIS status expected December 1991; IS expected December 1992)
ISO 9549	Information Processing Systems - Galvanic Isolation of Balanced Interchange Circuits, 15 October 1990
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TR 9575	OSI Routing Framework, 1 June 1990
ISO 9576-1♦	Information Technology - Open Systems Interconnection - Presentation Protocol to Provide the Connectionless-Mode Presentation Service, 1 July 1990 [SC21 N 4934]
DIS 9576–2	Information Technology - Open Systems Interconnection - Presentation Protocol to Provide the Connectionless-Mode Presentation Service - Part 2: PICS Proforma for Connectionless Presentation Protocol, 4 July 1991 [SC21 N 5930] (balloting ended 4 January 1991; IS expected February 1992)
TR 9577♦	Protocol Identification in the OSI Network Layer, 15 October 1990
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ISO 9592-1	Information Processing Systems - Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 1: Functional Description, May 1989
ISO 9592-1 AM 1	Information Processing Systems - Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 1: Functional Description, Amendment 1: PHIGS Plus Support
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ISO 9592-4	Information Processing Systems - Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 4: PHIGS Plus (ballot closed 1 September 1990) [SC24 N 224]
ISO 9593-1	Information Processing Systems - Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 1: FORTRAN Binding, 22 August 1990
DIS 9593-2	Information Processing Systems - Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Language Bindings - Part 2: Extended Pascal, (awaiting DIS ballot)

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ISO 9594-1♦ Information Processing Systems - Open Systems Interconnection - The Directory - Part 1: Overview of Concepts, Models and Services, July 1990 [SC21 N 4701] (CCITT X.500)

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ISO 9594-2 PDAM 1.3 Information Processing Systems - Open Systems Interconnection - The Directory - Part 2: Models, Amendment 1: Access Control, 16 May 1991 [SC21 N 5952] (balloting ends 3 September 1991; DIS text expected in November 1991, IS in October 1992)

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ISO 9594-3♦ Information Processing Systems - Open Systems Interconnection - The Directory - Part 3: Abstract Service Definition, July 1990 [SC21 N 4703] (CCITT X.511)

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ISO 9594-4♦ Information Processing Systems - Open Systems Interconnection - The Directory - Part 4: Procedures for Distributed Operations, July 1990 [SC21 N 4704] (CCITT X.518)

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ISO 9594-5♦ Information Processing Systems - Open Systems Interconnection - The Directory - Part 5: Protocol Specifications, July 1990 [SC21 N 4705] (CCITT X.519)

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1991 [SC21 N 5947] (balloting ends 3 September 1991; DIS text expected in November 1991, IS in October 1992)

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WD 9594-10♦ Information Technology - Open Systems Interconnection - The Directory - Part 10: Directory PICS Proforma, July 1990 [SC21 N 4913] (CD text expected in June 1992, DIS text in June 1993, and IS text in June 1994)

WD 9594-X♦ Information Technology - Open Systems Interconnection - The Directory - Part X: Text Suite Structure and Test Purposes and Abstract Test Suite for the OSI Directory, August 1990 [SC21 N 4951] (NWI not accepted]

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ISO 9595:1991(E) Information Technology - Open Systems Interconnection - Common Management Information Service (CMIS) Definition, CCITT X.710, April 1991 [SC21 N 5302] (April 1991 edition incorporates AD 1 and AD 2)

ISO 9595 PDAM 3 Information Technology - Open Systems Interconnection - Common Management Information Service (CMIS) Definition, Amendment 3: Support of Allomorphism, 26 November 1990 [SC21 N 4966] (PDAM expected June 1993, IS in March 1994, IS in March 1995)

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DIS 9636-1 Information Processing Systems - Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 1: Overview, Profiles, and Conformance, (ballot closed 8 September 1990)

DIS 9636-2 Information Processing Systems - Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 2: Control, Negotiation, and Errors, (ballot closed 8 September 1990)

DIS 9636-3 Information Processing Systems - Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 3: Output and Attributes, (ballot closed 8 September 1990)

DIS 9636-4 Information Processing Systems - Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 4: Segmentation, (ballot closed 8 September 1990)

DIS 9636-5 Information Processing Systems - Computer Graphics - Interfacing (CGI) Techniques for Dialogues with Graphical Devices - Functional Specification - Part 5: Input and Echoing, (ballot closed 8 September 1990)

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ISO 9646-1 PDAM 1 Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 1: General Concepts, Amendment 1: Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6173] (DIS text expected March 1992; IS in December 1992)

ISO 9646-1 PDAM 2 Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 1: General Concepts, Amendment 2: Multi-Party Testing Methodology, June 1991 [SC21 N 6178] (DIS text expected March 1992; IS in December 1992)

ISO 9646-2.2♦ Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 2: Abstract Test Suite Specification (Excluding Annexes E and F on TTCN), May 1991 [SC21 N 5867]

ISO 9646-2 Annex Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 2: Abstract Test Suite Specification, Annex: Guidelines for PICS Proformas [SC 6 N 6243]

ISO 9646-2 PDAM 1 Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 2: Abstract Test Suite Specification, Amendment 1: Protocol

Profile and Multi-Protocol Testing, June 1991 [SC21 N 6174] (DIS text expected March 1992; IS in December 1992)

ISO 9646-2 PDAM 2	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 2: Abstract Test Suite Specification, Amendment 2: Multi-Party Testing Methodology, June 1991 [SC21 N 6179] (DIS text expected March 1992; IS in December 1992)
ISO 9646-3♦	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 3: The Tree and Tabular Combined Notation (TTCN), July 1991
ISO 9646-3 PDAM 1	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 3: The Tree and Tabular Combined Notation (TTCN), Addendum 1: TTCN Extensions, June 1991 [SC21 N 6180] (PDAM expected November 1991, DAM June 1992, AM June 1993)
ISO 9646-4♦	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 4: Test Realization, May 1991 [SC21 N 5869]
ISO 9646-4 PDAM 1	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 4: Test Realization, Amendment 1: Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6175] (DIS text expected March 1992; IS in December 1992)
ISO 9646-4 PDAM 2	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 4: Test Realization, Amendment 2: Multi-Party Testing Methodology, June 1991 [SC21 N 6181] (DIS text expected March 1992; IS in December 1992)
ISO 9646-5♦	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 5: Requirements on Test Laboratories and Clients for the Conformance Assessment Process, May 1991 [SC21 N 5871]
ISO 9646-5 PDAM 1	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 5: Requirements on Test Laboratories and Clients for the Conformance Assessment Process, Amendment 1: Protocol Profile and Multi-Protocol Testing, June 1991 [SC21 N 6176] (DIS text expected March 1992; IS in December 1992)
ISO 9646-5 PDAM 2	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 5: Requirements on Test Laboratories and Clients for the Conformance Assessment Process, Amendment 2: Multi-Party Testing Methodology, June 1991 [SC21 N 6182] (DIS text expected March 1992; IS in December 1992)
CD 9646-6	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 6: Protocol Profile Test Specification, June 1991 [SC21 N 6177] (DIS text expected March 1992; IS in December 1992)
WD 9646-7	Information Processing Systems - OSI Conformance Testing Methodology and Framework - Part 7: Requirements and Guidelines on Implementation Conformance Statement (ICS) and ICS Proformas, June 1991 (new work item) (CD expected June 1992)
ISO 9660	Information Processing - Volume and File Structure of CD-ROM for Information Exchange, April 1988
ISO 9735	Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) - Application Level Syntax Rules, July 1988
DIS 9796	Information Processing - Digital Signature Scheme Giving Message Recovery, 1989
ISO 9797	Information Processing - Data Cryptographic Techniques - Data Integrity Mechanisms Using a Cryptographic Check Function Employing a Block Cypher Algorithm, 1989
DIS 9798-1	Information Processing - Entity Authentication Mechanisms - Part 1: General Model

DP 9798-2	Information Processing - Entity Authentication Mechanisms - Part 2: Entity Authentication Mechanisms Using Symmetric Algorithms
ISO 9804♦	Information Processing Systems - Open Systems Interconnection - Service Definition for the Commitment, Concurrency, and Recovery (CCR) Service Element, July 1990 [SC21 N 4611, 20 April 1990] (CCITT X.237)
ISO 9804 PDAM 1♦	Information Processing - Open Systems Interconnection - Service Definition for the Commitment, Concurrency, and Recovery (CCR) Service Element, Amendment 1: Enhancements, 26 October 1990 [SC21 N 5122] (DIS text expected March 1993, IS in March 1994)
ISO 9804 PDAM 2	Information Processing - Open Systems Interconnection - Service Definition for the Commitment, Concurrency, and Recovery (CCR) Service Element, Amendment 2: Session Mapping Changes (Additional Resynchronization Functionality), October 1990 [SC21 N 5343] (DIS text expected in 1991, IS in March 1992)
ISO 9804 WDAM 3♦	Information Processing - Open Systems Interconnection - Service Definition for the Commitment, Concurrency, and Recovery (CCR) Service Element, Amendment 3: Restart (CD text expected May 1992)
ISO 9805♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Protocol, July 1990 [SC21 N 4612, 20 April 1990] (CCITT X.247)
ISO 9805 PDAM 1♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Protocol, Amendment 1: Enhancements, 1 June 1990 [SC21 N 5120] (DIS text expected March 1993, IS text March 1994)
ISO 9805 PDAM 2	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Service Element, Amendment 2: Session Mapping Changes (Additional Resynchronization Functionality), 26 October 1990 [SC21 N 5123] (DIS text expected in 1991, IS in March 1992)
ISO 9805 WDAM 3♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Protocol, Amendment 3: Restart (CD text expected May 1992, DIS in May 1993, IS in May 1994)
CD 9805-2♦	Information Processing Systems - Open Systems Interconnection - Protocol Specification for the Commitment, Concurrency, and Recovery (CCR) Protocol - Part 2: CCR PICS Proforma, 28 March 1991 [SC21 N 5797] (DIS text expected November 1991, IS text November 1992)
DIS 9834-1	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part 1: General Procedures, March 1990 [SC21 N 4352] (ballot closed 2 February 1991; IS expected August 1991)
ISO 9834-2♦	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part 2: Registration Procedures for OSI Document Types, November 1990 [SC21 N 5275] (approved 12 June 1991; IS text expected in late 1991)
ISO 9834-3	Information Technology - Open Systems Interconnection - Procedures for OSI Registration Authorities - Part 3: Procedures for Specific Registration of Joint Object Identifier Component Values for Joint ISO-CCITT Use, 27 September 1990 [SC21 N 4718, April 1990]
ISO 9834-4	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part 4: Registration of VTE Profiles, July 1991 [SC21 N 4325, 10 January 1990]

ISO 9834-5♦	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part 5: Register of VT Control Object Identifiers, July 1991 [SC21 N 4322, 10 January 1990]
DIS 9834-6♦	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part 6: Registration Authority Procedures for Application Process Titles and Application Entity Titles, September 1990 [SC21 N 5218, July 1990] (DIS ballot failed 25 April 1991)
WD 9834-B	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part B: Registration of Abstract Syntaxes, 1990
WD 9834-C	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part C: Registration of Transfer Syntaxes, 1990
WD 9834-D	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part D: Registration of Application Contexts, 1990 (work suspended by SC21, November 1989)
WD 9834-E	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part E: Registration of System Titles, 1990 (will probably be incorporated in OSI management standards)
WD 9834-F	Information Technology - Open Systems Interconnection - Procedures for Specific OSI Registration Authorities - Part F: Registration of Authentication Mechanisms, 1990 (WITHDRAWN; cancelled by SC21, November 1989)
ISO 9899	Programming Languages - C, 1990
ISO 9945-1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1: System Interface, 1990
DP 9945-1.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.1: Language Independent Base (WG15 work item based on IEEE P1003.1c)
DP 9945-1.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.2: Real-time and Extensions (WG15 work item based on IEEE P1003.4 and .1b)
DP 9945-1.3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3: Distribution Services (WG15 work item based on IEEE P1003.8)
DP 9945-1.3.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.1: Transparent File Access (WG15 work item based on IEEE P1003.8)
DP 9945-1.3.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.2: Remote Procedure Call (WG15 work item based on IEEE P1237)
DP 9945-1.3.3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.3: Transport Interface (WG15 work item based on IEEE P1003.11)
DP 9945-1.3.4	Portable Operating System Interface for Computer Environments (POSIX) - Part 1.3.4: Name Space/Directory Services (WG15 work item based on IEEE P1003.12)
DP 9945-2	Portable Operating System Interface for Computer Environments (POSIX) - Part 2: Shell and Utilities, 1990 [failed registration ballot; new draft requested for registration (on hold)]
DP 9945-2.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 2.1: Shell and Utilities (WG15 work item based on IEEE P1003.2)
DP 9945-2.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 2.2: User Portability Extensions (WG15 work item based on IEEE P1003.2a)
DP 9945-3	Portable Operating System Interface for Computer Environments (POSIX) - Part 1: System Management
DP 9945-3.1	Portable Operating System Interface for Computer Environments (POSIX) - Part 3.1: General Services ((WG15 work item based on IEEE P1003.7)

DP 9945-3.2	Portable Operating System Interface for Computer Environments (POSIX) - Part 3.2: Batch Services ((WG15 work item based on IEEE P1003.10)
TR 9973	Registration of Graphical Items, 1989
ISO 9979	Information Processing - Data Encipherment - Procedures for the Registration of Cryptographic Algorithms, July 1990 [SC27 N 88]
CD 9995-1	Information Technology, Keyboard Layouts for Text and Office Systems, Part 1: General Principles Governing Keyboard Layouts
CD 9995-2	Information Technology, Keyboard Layouts for Text and Office Systems, Part 2: Alphanumeric Section
CD 9995-3	Information Technology, Keyboard Layouts for Text and Office Systems, Part 3: Common Secondary Layout of Alphanumeric Zone of Alphanumeric Section
DP 9995-4	Information Technology, Keyboard Layouts for Text and Office Systems, Part 4: Principles Governing the Placement of Characters and Symbols on Keys
CD 9995-5	Information Technology, Keyboard Layouts for Text and Office Systems, Part 5: Editing Section
CD 9995-6	Information Technology, Keyboard Layouts for Text and Office Systems, Part 6: Functional Section
CD 9995-7	Information Technology, Keyboard Layouts for Text and Office Systems, Part 7: Symbols Used to Represent Functions
TR 10000-1	Information Technology - Framework of International Standardized Profiles (ISPs) - Part 1: Taxonomy Framework, [SGFS N 184. 9 February 1990], 16 July 1990
TR 10000-2	Information Technology - Framework of International Standardized Profiles (ISPs) - Part 2: Taxonomy of Profiles, [SGFS N 185. 9 February 1990], 16 July 1990
DTR 10000-2.2(E)	Information Technology - Framework of International Standardized Profiles (ISPs) - Part 2: Taxonomy of Profiles, 28 June 1991 [SGFS N 384]
ISO 10021-1♦	Information Processing - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 1: System and Service Overview, June 1988 (see CCITT X.400), 1990
ISO 10021-2♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 2: Overall Architecture, June 1988 (see CCITT X.402), 1990
ISO 10021-3♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 3: Abstract Service Definition Conventions, June 1988 (see CCITT X.407), 1990
ISO 10021-4♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 4: Message Transfer System: Abstract Service Definition and Procedures, June 1988 (see CCITT X.411), 1990
ISO 10021-5♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 5: Message Store: Abstract Service Definition, June 1988 (see CCITT X.412), 1990
ISO 10021-6♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 6: Protocol Specifications, June 1988 (see CCITT X.419), 1990
ISO 10021-7♦	Information Processing Systems - Text Communication - Message Oriented Text Interchange System (MOTIS) - Part 7: Interpersonal Messaging System, June 1988 (see CCITT X.420), 1990
ISO 10022	Information Processing Systems - Open Systems Interconnection - Physical Service Definition, (CCITT X.211), 1 August 1990

PDTR 10023♦	Telecommunications and Information Exchange Between Systems - A Formal Description of ISO 8072 in LOTOS, March 1988 (awaiting decision concerning further progression)
CD 10024♦	Telecommunications and Information Exchange Between Systems - A Formal Description of ISO 8073 in LOTOS, April 1988
DIS 10025-1♦	Information Processing Systems - Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 1: General Principles, 1989
CD 10025-2♦	Information Processing Systems - Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 2: Test Suite Structure and Test Principles, 1989
DP 10025-3♦	Information Processing Systems - Transport Conformance Testing for Connection Oriented Transport Protocol Operating Over the Connection Oriented Network Service (CONS) - Part 3: Abstract Test Suite Specification, 1989
DIS 10026-1.2♦	Distributed Transaction Processing (TP) - Part 1: Model, July 1991 [SC21 N 5671] (text is considered stable, but a second DIS was issued)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Security, WDAMs, July 1991 [SC21 N 6232] (CD text expected June 1992)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Association Management, WDAMs, July 1991 [SC21 N 6233] (CD text expected June 1992)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Heuristic Decisions, WDAMs, January 1990 [SC21 N 4167] (inactive; target dates dependent on national body input)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Commitment Optimization, WDAMs, July 1991 [SC21 N 6239] (CD text expected in November 1992, DIS in November 1993, IS in November 1994)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Distributed Transaction Processing Dialogue Recovery and User Suspension of a Dialogue, WDAMs, July 1990 [SC21 N 6235] (CD text expected June 1992, DIS in June 1993, IS in June 1994)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Distributed Transaction Processing Savepoints, January 1990 [SC21 N 4171] (new work item; not accepted by JTC1, June 1990)
DIS 10026-1/3	Draft Amendments to Parts 1-3: Transaction Processing Sub-Transactions, SC21/WG5, WDAMs, July 1991 [SC21 N 6236] (formal WD text expected June 1992, CD text in June 1993, DIS in June 1994, IS in June 1995)
DIS 10026-1/4	Draft Amendments to Parts 1-3: Transaction Processing Separate Data and Commit Associations, WDAMs, July 1991 [SC21 N 6240] (formal WD text expected June 1992, CD text in June 1993, DIS in June 1994, IS in June 1995)
DIS 10026-2.2♦	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 2: Service Definition, July 1991 [SC21 N 5673] (text is considered stable, but a second DIS was issued)
DIS 10026-3♦	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 3: Transaction Processing Protocol Specification, July 1991 [SC21 N 5675] (second DIS is expected October 1991)
CD 10026-4	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 4: PICS Proforma, SC21/WG5, 14 July 1990 [SC21 N 5159] [JTC1 N 779] (second CD is expected October 1991, DIS in June 1992, IS in June 1993)
CD 10026-5	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 5: Application Context Proforma, SC21/WG5, July 1990 [SC21 N 5160] [JTC1 N 774] (CD ballot closed 9 July 1991; DIS text expected October 1991, IS in October 1992)

CD 10026-6	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 6: Unstructured Data Transfer, July 1991 [SC21 N 4166, January 1990; JTC1 N 775] (DIS text expected in October 1991, IS in October 1992)
WD 10026-7	Information Processing Systems - Open Systems Interconnection - Distributed Transaction Processing (TP) - Part 7: Other Data Transfer, January 1990 [SC21 N 4166] (new work item; CD text expected November 1992]
ISO 10027	Information Technology - Information Resource Dictionary System (IRDS) Framework, June 1990 [SC21 N 4727, 2 May 1990]
DIS 10028-1	Definition of the Relaying Functions of a Network Layer Intermediate System, Part 1: Connection-mode Network Service (awaiting DIS ballot)
CD 10028-2	Definition of the Relaying Functions of a Network Layer Intermediate System, Part 2: Connectionless Network Service (awaiting CD ballot)
TR 10029♦	Information Processing Systems - Data Communications - Operation of an X.25 Interworking Unit, 15 March 1989
ISO 10030–1	Information Processing Systems - Open Systems Interconnection - End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP) [SC6 N 5006], 11 October 1990
ISO 10030-1 PDAM 1	Information Processing Systems - Open Systems Interconnection - End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP), Amendment 1: Dynamic Discovery of OSI NASP Addresses by End Systems (New Work Item)
ISO 10030-1 PDAM 3	Information Processing Systems - Open Systems Interconnection - End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP), Amendment 3: Specification of IS-SNARE Interactions (ballot closed 8 February 1991)
CD 10030-2	Information Processing Systems - Open Systems Interconnection - End System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8878 (X.25 PLP), Part 2: PICS Proforma (awaiting CD ballot)
ISO 10031-1	Information Processing - Text Communication - Distributed-Office-Applications Model (DOAM) - Part 1: General Model, 1991
ISO 10031-2	Information Processing - Text Communication - Distributed-Office-Applications Model (DOAM) - Part 2: Referenced Data Transfer, 1991
DIS 10032♦	Information Technology - Reference Model of Data Management, 13 May 1991 [SC21 N 5991] (balloting ends 4 January 1992)
DP 10033	Information Processing - Text and Office Systems - Recording of Documents Conforming to ISO 8613 on Flexible Disk Cartridges Conforming to ISO 9293, May 1988
DTR 10034	Guidelines for the Preparation of Conformity Clauses in Programming Language Standards (Technical Report, Type 3), July 1988
ISO 10035♦	Information Processing Systems - Open Systems Interconnection Connectionless ACSE Protocol Specification, 1 June 1990 [SC21 N 4938]
WD 10035-2	Information Processing Systems - Open Systems Interconnection Connectionless ACSE Protocol Specification - Part 2: PICS Proforma for Connectionless ACSE Protocol, July 1989 [SC21 N 3218] (CD text possible in June 1991)
DIS 10036	Procedure for Registration of Glyph and Glyph Collection Identifiers (ballot closed 17 November 1990)
TR 10037	Information Processing - SGML and Text-Entry Systems - Guidelines for SGML Syntax-Directed Editing Systems, (awaiting publication)

DIS 10038	Information Processing Systems - Local Area Networks - MAC Sublayer Interconnection (MAC Bridging), (awaiting DIS ballot)
DIS 10038 PDAM 1	Information Processing Systems - Local Area Networks - MAC Sublayer Interconnection (MAC Bridging), Amendment 1: Specification of Management Information for CMIP (awaiting PDAM ballot)
DIS 10038 PDAM 2	Information Processing Systems - Local Area Networks - MAC Sublayer Interconnection (MAC Bridging), Amendment 2: Source Routing Supplement (ballot closed 7 March 1991)
ISO 10039	Information Processing Systems - Local Area Networks - MAC Service Definition, 26 October 1990
ISO 10040♦	Information Processing Systems - Open Systems Interconnection - Systems Management Overview, August 1991 [SC21 N 4865, September 1990]
DIS 10116	Information Processing - Modes of Operation for an N-bit Block Cipher Algorithm, 1989 [SC27 N 86]
DIS 10148	Information Processing Systems - Basic Remote Procedure Call (RPC) Using OSI Remote Operations, 9 March 1989 [SC21 N 3463; fast-track ballot failed; DIS 10148 WITHDRAWN; proposal for new work item, SC21 N 4153, January 1990] (CD text for RPC model, service, and protocol now planned for June 1991) [SC21 N 5584, second working draft, 7 January 1991]
DIS 10149	Information Processing Systems - Data Interchange on Read-Only 120-mm Optical Data Disks (CD-ROM), August 1988
ISO 10164-1♦	Information Technology - Open Systems Interconnection - Systems Management - Part 1: Object Management Function, July 1991 [SC21 N 4855, September 1990]
ISO 10164-2♦	Information Technology - Open Systems Interconnection - Systems Management - Part 2: State Management Function, July 1991 [SC21 N 4856, September 1990]
ISO 10164-3♦	Information Technology - Open Systems Interconnection - Systems Management - Part 3: Attributes for Representing Relationship, July 1991 [SC21 N 4857, September 1990]
ISO 10164-4♦	Information Technology - Open Systems Interconnection - Systems Management - Part 4: Alarm Reporting Function, July 1991 [SC21 N 4858, September 1990]
ISO 10164-5♦	Information Technology - Open Systems Interconnection - Systems Management - Part 5: Event Report Management Function, July 1991 [SC21 N 4860, September 1990]
ISO 10164-6♦	Information Technology - Open Systems Interconnection - Systems Management - Part 6: Log Control Function, July 1991 [SC21 N 4862, September 1990]
ISO 10164-7♦	Information Technology - Open Systems Interconnection - Systems Management - Part 7: Security Alarm Reporting Function, July 1991 [SC21 N 4874, September 1990]
DIS 10164-8	Information Technology - Open Systems Interconnection - Systems Management - Part 8: Security Audit Trail Function, 8 July 1991 [SC21 N 6283] (CCITT X.740) (IS status expected in June 1992)
CD 10164-9.2	Information Technology - Open Systems Interconnection - Systems Management - Part 9: Objects and Attributes for Access Control, 20 June 1991 [SC21 N 5764] (second CD ballot ends 4 October 1991; DIS text expected December 1991, IS in December 1992) (CCITT X.741)
CD 10164-10.2	Information Technology - Open Systems Interconnection - Systems Management - Part 10: Accounting Meter Function, July 1991 [SC21 N 5648, 30 January 1991] (second CD ballot expected in 1991; DIS text expected in March 1992, IS in March 1993) (CCITT X.742)
CD 10164-11.2	Information Technology - Open Systems Interconnection - Systems Management - Part 11: Workload Monitoring Function, 13 May 1991 [SC21 N 5767] (DIS text

	expected in 1991; DIS text expected December 1991, IS in December 1992) (CCITT X.739)
CD 10164-12	Information Technology - Open Systems Interconnection - Systems Management - Part 12: Test Management Function, CCITT X.745, 31 May 1991 [SC21 N 5517] (DIS text expected October 1991, IS in December 1992)
CD 10164-13	Information Technology - Open Systems Interconnection - Systems Management - Part 13: Measurement Summarization Function, CCITT X.738, 31 May 1991 [SC21 N 5519] (DIS text expected in October 1991, IS in December 1992)
WD 10164-X	Information Technology - Open Systems Interconnection - Systems Management - Part X: Software Management Function, July 1991 [SC21 N 6040] (CD text expected June 1993, DIS in March 1994, IS in March 1995)
WD 10164-cdt	Information Technology - Open Systems Interconnection - Systems Management - Part cdt: Confidence and Diagnostic Test Categories, CCITT X.737, December 1990 [SC21 N 5518] (CD text expected December 1991, DIS in August 1992, IS in August 1993)
WD 10164-A	Information Technology - Open Systems Interconnection - Systems Management - Part A: Time Management Function, July 1990 [SC21 N 4953] [JTC1 N 763] (new work item; standard will have two parts: representation of time and mechanisms for the distribution and synchronization of time; CD text expected June 1993, DIS in March 1994, IS in March 1995) (CCITT X.743)
WD 10164-sm	Information Technology - Open Systems Interconnection - Systems Management - Part sm: Systems Management Relationship Model, June 1991 [SC21 N 6041] (CD expected in December 1992, DIS in August 1993, IS in August 1994)
WD 10164-rtm	Information Technology - Open Systems Interconnection - Systems Management - Part rtm: Response Time Monitoring, August 1990 [SC21 N 4949; JTC1 N 963] (CD text expected December 1993, DIS in August 1994, IS in August 1995)
WD 10164-s	Information Technology - Open Systems Interconnection - Systems Management - Part s: Scheduling Function, June 1991 [SC21 N 6021](CD text expected June 1992, DIS in March 1993, IS in March 1994)
DIS 10165-1♦	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 1: Management Information Model, September 1990 [SC21 N 5252] (DIS ballot failed 22 April 1991, but editing meeting in May 1991 recommended progression to IS)
DIS 10165-2♦	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 2: Definition of Management Information, September 1990 [SC21 N 4867] (IS text expected late 1991)
DIS 10165-4♦	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 4: Guidelines for the Definition of Managed Objects, September 1990 [SC21 N 4852] (DIS ballot failed 22 April 1991, but editing meeting in May 1991 recommended progression to IS)
CD 10165-5	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 5: Generic Management Information, July 1991 [SC21 N 6025] (DIS text expected in March 1992, IS in March 1993) (previously entitled Generic Managed Objects)
CD 10165-6	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 6: Requirements and Guidelines for Management Information Conformance Statement (MICS) Proformas, July 1991 [SC21 N 6027] (DIS text expected in March 1992, IS in March 1993)
WD 10165-7	Information Technology - Open Systems Interconnection - Structure of Management Information - Part 7: Management Information Register and Registration Procedures, (CD expected in June 1992, DIS in December 1992, IS in December 1993)

WD xxxx(E)	Information Technology - Open Systems Interconnection - Managed Object Conformance Statement (MOCS) Proforma, 14 February 1991 [SC21 N 5686]
ISO 10166-1	Document Filing and Retrieval (DFR) - Part 1: Abstract Service Definition and Procedures, 1991 [SC18 N 2069, February 1989]
ISO 10166-2	Document Filing and Retrieval (DFR) - Part 2: Protocol Specification, 1991 [SC18 N 2070, February 1989]
TR 10167♦	Information Processing Systems - Open Systems Interconnection - Draft Technical Report on Guidelines for the Application of Estelle, LOTOS, and SDL, July 1991 [SC21 N 4259, 18 January 1990] (IS text expected December 1991)
DIS 10168-1♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the Session Protocol - Part 1: Test Suite Structure and Test Purposes, 19 April 1990 [SC21 N 4159, 11 December 1989] (IS status expected in late 1991)
WD 10168-2♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the Session Protocol - Part 2: Generic Test Suite, July 1989 [SC21 N 3667] (CD text expected October 1993, DIS in October 1994, IS in October 1995)
WD 10168-3♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the Session Protocol - Part 3: Abstract Test Suite for CS Method, July 1989 [SC21 N 3667] (CD text expected in late 1991, DIS in June 1992, IS in June 1993)
DIS 10168-4♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the Session Protocol - Part 4: Session Test Management Protocol Specification, 17 December 1990 [SC21 N 5026]
DIS 10169-1.2♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the ACSE Protocol - Part 1: Test Suite Structure and Test Purposes, April 1990 [SC21 N 4158] (ballot closed 19 October 1990; ; editing meeting January 1991; proposed progression to IS not defined)
ISO 10170-1♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the FTAM Protocol - Part 1: Test Suite Structure and Test Purposes, June 1991 [SC21 N 6269]
WD 10170-2♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the FTAM Protocol - Part 2: FTAM Abstract Test Suite, June 1989 [SC21 N 3665] (CD text expected October 1992, DIS in June 1993, IS in June 1994)
WD 10170-3♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the FTAM Protocol - Part 3: ACSE Abstract Test Suite Embedded Under FTAM, 1989 (formal WD text expected June 1992, CD text in June 1993, DIS in June 1994, IS in June 1995)
WD 10170-4♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the FTAM Protocol - Part 4: Presentation Abstract Test Suite Embedded Under FTAM, 1989 (formal WD text expected June 1992, CD text in June 1993, DIS in June 1994, IS in June 1995)
WD 10170-5♦	Information Technology - Open Systems Interconnection - Conformance Test Suite for the FTAM Protocol - Part 5: Session Abstract Test Suite Embedded Under FTAM, 1989 (formal WD text expected June 1992, CD text in June 1993, DIS in June 1994, IS in June 1995)
TR 10171	List of Standard Data Link Layer Protocols that Utilize HDLC Classes of Procedures (awaiting publication)
TR 10171 PDAM 1	List of Standard Data Link Layer Protocols that Utilize HDLC Classes of Procedures, Amendment 1: Registration of XID Format Identifiers and Private Parameter Set Identifiers (ballot closed 10 March 1991)
TR 10172	Information Processing Systems - Data Communications - Network/Transport Protocol Interworking Specification [SC6 N 5906, 29 March 1990], 15 October 1990

DIS 10173	ISDN Primary Access Connector at Reference Points S and T (ballot closed 1 May 1990)
DTR 10174	Logical Link Control (type 2 Operation) Test Purposes (awaiting DTR publication)
DIS 10177	Information Processing Systems - Data Communications - Intermediate-System Support of the OSI Connection-Mode Network Service Using ISO 8208 in Accordance with ISO 10028, (ballot closed 23 February 1991)
PDTR 10178	Structure and Coding of Link Service Access Point Addresses in LANs
CD 10179	Document Style Semantics and Specification Language (DSSSL), 28 June 28 1991, (awaiting CD ballot)
CD 10180	Standard Page Description Language (SPFL) (awaiting CD ballot)
WD 10181-1♦	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 1: Overview, July 1991 [SC21 N 6166] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
DIS 10181-2	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 2: Authentication Framework, 13 May 1991 [SC21 N 5727] (IS status expected in March 1992)
DIS 10181-2 WDAM 1	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 2: Authentication Framework, Amendment 1: Authentication Elements, July 1991 [SC21 N 6172] (new work item in WG1)
CD 10181-3♦	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 3: Access Control Framework, July 1991 [SC21 N 6168] (DIS text expected in March 1992; IS status in December 1992)
WD 10181-4♦	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 4: Non-Repudiation Framework, July 1991 [SC21 N 6165] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
WD 10181-5♦	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 5: Confidentiality Framework, July 1991 [SC21 N 6164] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
WD 10181-6	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 6: Integrity Framework, July 1991 [SC21 N 6163] (CD status expected in June 1992, DIS in June 1993, IS in June 1994)
CD 10181-7	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 7: Security Audit Framework, July 1991 [SC21 N 6169] (DIS text expected in March 1992; IS status in December 1992)
WD 10181-8	Information Technology - Open Systems Interconnection - Security Frameworks for Open Systems - Part 8: Key Management
DTR 10183	Text and Office Systems - ODA and Interchange Format - Testing Methodology and Abstract Cases - Implementation Testing, 1991
CD 10184-1.2	Terminal Management - Model, July 1991 [SC21 N 4176, June 1990] (DIS text expected in July 1992, IS in July 1993)
WD 10184-2	Terminal Management - Service, July 1991 [SC21 N 4176, June 1990] (CD text expected July 1992, DIS in December 1992, IS in December 1993)
WD 10184-3	Terminal Management - Protocol, July 1991 [SC21 N 4176, June 1990] (CD text expected July 1992, DIS in December 1992, IS in December 1993)
PDTR 10182	Binding Techniques for Programming Languages [SC22 /WG11 N 754], 6 February 1990
ISO 10206	Object Oriented Extensions to Pascal, 1991
DIS 10222	Enhanced Small Device Interface, 1991
DIS 10279	Programming Languages - Full BASIC, 1991

DP 10303	Standard for Exchange of Product Model Data (STEP)
DIS 10588	Use of the X.29 PLP in Conjunction with X.21/X.21 bis to Provide the OSI CONS (awaiting DIS ballot)
DIS 10589	Intermediate System to Intermediate System Routing Information Exchange Protocol for Use in Conjunction with ISO 8473 (awaiting DIS ballot)
ISP 10607-1	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by FTAM, 26 April 1990 [SGFS N 210] (submitted by SPAG) ISP accepted December 1990
ISP 10607-2	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes, 26 April 1990 [SGFS N 210] (submitted by SPAG) ISP accepted December 1990
ISP 10607-2 AD 1	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 2: Definition of Document Types, Constraint Sets and Syntaxes, Addendum 1: Additional Definitions, Approved 27 May 1991 [SGFS N 363]
ISP 10607-3	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 3: AFT 11 - Simple File Transfer Service (Unstructured), 26 April 1990 [SGFS N 210] (submitted by SPAG) ISP accepted December 1990
ISP 10607-4	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 4: AFT 12 - Positional File Transfer Service, Approved 27 May 1991 [SGFS N 360]
ISP 10607-4 DAD 1	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 4: AFT 12 - Positional File Transfer Service, Addendum 1: Additional Definitions, 17 July 1990 [SGFS N 245]
ISP 10607-5	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 5: AFT 22 - Positional File Access Service, Approved 27 May 1991 [SGFS N 361]
ISP 10607-6	Information Technology - International Standard Profile - AFT nn - File Transfer, Access, and Management - Part 6: AFT 3 - File Management Service, Approved 27 May 1991 [SGFS N 362]
PDISP 10608-1	International Standardized Profile TA-Connection-mode Transport Service over Connectionless Network Service, Part 1: General Overview and Subnetwork-Independent Requirements
PDISP 10608-2	International Standardized Profile TA-Connection-mode Transport Service over Connectionless Network Service, Part 2: TA51 Profile Including Subnetwork-dependent Requirements for CSMA/CD LANs (ballot closed 13 December 1990)
PDISP 10608-5	International Standardized Profile TA-Connection-mode Transport Service over Connectionless Network Service, Part 5: TA1111/TA1121 Profiles Including Subnetwork-dependent Requirements for X.25 Packet Switched Data Networks Using Switched Virtual Circuits, (ballot closed 13 December 1990)
DISP 10609-1	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 1: Subnetwork-type Independent Requirements for Group TB (ballot closed 13 December 1990)
DISP 10609-2	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 2: Subnetwork-type Independent Requirements for Group TC, (ballot closed 13 December 1990)

DISP 10609-3	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 3: Subnetwork-type Independent Requirements for Group TD (ballot closed 13 December 1990)
DISP 10609-4	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 4: Subnetwork-type Independent Requirements for Group TE (ballot closed 13 December 1990)
DISP 10609-5	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 5: Definition of Profile TB 1111/TB 1121, (ballot closed 13 December 1990)
DISP 10609-6	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 6: Definition of Profile TC 1111/TC 1121(ballot closed 13 December 1990)
DISP 10609-7	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 7: Definition of Profile TD 1111/TD 1121(ballot closed 13 December 1990)
DISP 10609-8	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 8: Definition of Profile TE 1111/TE 1121(ballot closed 13 December 1990)
DISP 10609-9	International Standardized Profiles TB, TC, TD, and TE - Connection-mode Transport Service over Connection-mode Network Service, Part 9: Subnetwork-type Dependent Requirements for Network Layer, Data Link Layer, and Physical Layer Concerning Permanent Access to a Packet Switched Data Network Using Virtual Call, (ballot closed 13 December 1990)
CD 10641	Conformance Testing of Implementations of Graphics Standards, 1991
DP 10646	Information Processing - Multiple Octet Coded Character Set, SC27, 14 November 1989 [SC21 N 4627]
DIS 10728	Information Resource Dictionary System (IRDS) Services Interface, July 1991 [SC21 N 5147, July 1990]
DIS 10729-1♦	Conformance Test Suite for the Presentation Protocol, Part 1: Test Suite Structure and Test Purposes for the Presentation Protocol, SC21/WG6, 27 June 1991 [SC21 N 5019, August 1990] (IS expected June 1992)
WD 10729-2	Conformance Test Suite for the Presentation Layer, Part 2: Test Suite for ASN.1 Encodings and Test Purposes for Presentation Protocol, February 1990 [SC21 N 4151] (CD text expected in October 1991, DIS in June 1992, IS in June 1993)
DTR 10730	Information Technology - Open Systems Interconnection - Tutorial on Naming and Addressing, June 1991 [SC21 N 5102, August 1990] (IS text expected June 1992)
DIS 10731	Information Technology - Open Systems Interconnection - Conventions for Service Definitions, March 1991 [SC21 N 5933] (will supercede TR 8509; IS expected March 1992)
CD 10732	Use of X.25 PLP to Provide the OSI CONS Over the Telephone Network (ballot closed 20 February 1991)
CD 10733	Information Technology - Telecommunications and Information Exchange Between Systems - Elements of Management Information Related to OSI Network Layer Standards [SC21 N 5560, 3 January 1991; SC6 N 6413, 11 December 1990]
CD 10736	Specification of the Elements of Management Information Related to OSI Transport Layer Standards (ballot closed 9 March 1991)
PDTR 10734	Guidelines for Bridged LAN Source Routing Operation by End Systems (ballot closed 8 March 1991)
PDTR 10735	Standard Group MAC Addresses (ballot Closed 10 March 1991)

DIS 10739-1	Information Technology - Open Systems Interconnection - Conformance Test Suite for 9041 - Virtual Terminal Basic Class Protocol - Part 1: Test Suite Structure and Test Purposes [SC21 N 5158, 2 January 1991] (IS expected July 1992)
CD 10744	Representation of Duration and Synchronization in Time-Dependent Documents
CD 10745	Information Technology - Open Systems Interconnection - Upper Layer Security Model, 28 June 1991 [SC21 N 6095] (CD ballot closes 22 October 1991)
WD 10746-1♦	Basic Reference Model for Open Distributed Processing - Part 1: Introduction (proposal for new work item, 1987) [SC21 N 6083] (CD text expected June 1994)
CD 10746-2♦	Basic Reference Model for Open Distributed Processing - Part 2: Concepts and Modelling Tools (proposal for new work item, 1987) [SC21 N 6079] 30 May 1991 (proposed CD expected June 1992)
WD 10746-3♦	Basic Reference Model for Open Distributed Processing - Part 3: Framework for ODP Standards (proposal for new work item, 1987) [SC21 N 6080] 30 May 1991 (CD text expected June 1992)
WD-10746-4♦	Basic Reference Model for Open Distributed Processing - Part 4: User Guide (proposal for new work item, 1987) [SC21 N 6083] (CD text expected May 1994)
WD 10746-5	Basic Reference Model for Open Distributed Processing - Part 5: Architectural Semantics, Specification Techniques and Formalisms [SCC2 N 6082] 30 May 1991 (CD text expected May 1993)
CD 10918-1	Digital Compression and Coding of Continuous-Tone Still Images, Part 1: Requirements and Guidelines, February 1991
CD 10918-2	Digital Compression and Coding of Continuous-Tone Still Images, Part 2: Compliance Testing
DIS 10967	Language Compatible Arithmetic Standard (LCAS), [SC22 N 796], Version 2.2A, 31 May 1990 (undergoing public review July 1991)
DIS 10994	Information Technology - Data Interchange on 90 mm Flexible Disk Cartridges Using MFM Recording at 31 831 FTPRAD on 80 Tracks on Each Side, 21 June 1991
CD 11072	Information Processing Systems - Computer Graphics - Reference Model of Computer Graphics, 1991
CD 11172	Coding of Moving Pictures and Associated Audio, December 1990
pDISP 11183-1	Information Technology - International Standardized Profiles AOMnn OSI Management - Management Communications Protocols - Part 1: Specification of ACSE, Presentation and Session Protocols for the Use by ROSE and CMISE, Second Version, 27 April 1991 [SGFS N 357 and 358, 24 May 1991]
pDISP 11183-2	Information Technology - International Standardized Profiles AOMnn OSI Management - Management Communications Protocols - Part 2: Enhanced Management Communications, Fourth Version, 27 April 1991 [SGFS N 359, 24 May 1991]
pDISP 11183-3	Information Technology - International Standardized Profiles AOMnn OSI Management - Management Communications Protocols - Part 3: AOM11 - Basic Management Communications, Draft pDISP text, First Version, 23 May 1991 [IST/21:2808]
DIS 11319	Information Technology - 8 mm Wide Magnetic Tape Cartridge for Information Interchange -- Helical Scan Recording, 21 June 1991
DIS 11321	Information Technology - 3,81 mm Wide Magnetic Tape Cartridge for Information Interchange -- Helical Scan Recording-- Data/Dat Format, 21 June 1991
JTC1 N 474	Proposal for a New Work Item: OSI Upper Layers Security Model, 21 July 1989 [SC21 N 5447, 30 October 1990]

JTC1 N 535	Directives for the Work of ISO/IEC Joint Technical Committee 1 (JTC1) on Information Technology, Secretariat, 31 August 1989
JTC1 N 598	JTC1 Strategic Plan, Editing Team, 20 November 1989
JTC1 N 996	IST/21 N 2478, Catalogue of Security Related Projects for consideration at the JTC 1 Workshop on Security 5-7 November 1990, 30 May 1990
JTC1 N 1011	Results of National Body Survey for Consideration at the JTC1 Workshop on Security, 5-7 November 1990, London, 10 October 1990
JTC1 N 1015	ISO/IEC JTC1/SC21 Presentation Materials for the Workshop on Security (Topic: Security for OSI Management), 10 October 1990
JTC1 N 1016	ISO/IEC JTC1/SC21 Presentation Materials for the Workshop on Security (Topic: OSI Security Architecture and Security Frameworks), 10 October 1990
JTC1 N 1161	Report of the Meeting of the Ad Hoc Technical Study Group on Multimedia and Hypermedia, 8 January 1991.
JTC1 N 1240	Presentation to the JTC 1 Advisory Group Regarding the Recommendations by the Technical Study Group on Multimedia and Hypermedia, 26 February 1991.
JTC1 N 1252	Summary of Voting on Document JTC1 N 1021, Proposal for a New Work Item on Data Management Export/Import for SQL and IRDS, JTC1 Secretariat, 20 February 1991
JTC1 N 1254	Summary of Voting on Document JTC1 N 1023, Proposal for a New Work Item on Information Resource Dictionary Systems (IRDS), JTC1 Secretariat, 20 February 1991
JTC1 N 1260	SC21 Request to Modify its Programme of Work, ISO/IEC JTC1, 5 March 1991
JTC1 SWG-EDI N 177	Conceptual Model for Electronic Data Interchange Standards and Services, 6 December 1990.

SGFS N 151	CCITT Liaison Statement on Work of SGFS, 6 November 1989 (includes X.220)
SGFS N 201	Information Processing Systems - International Standardized Profiles - Taxonomy Update, ISP Approval, and Maintenance Process, 7 May 1990 (standing SGFS document)
SGFS N 214	Catalogue of PICS Proforma Notations, SC21, 17 January 1991
SGFS N 219	An Example of T-Profiles Multi-Part ISP Structure, 11 June 1990
SGFS N 224	Documents Relating to Applications Portability Profile Work from JTC1/TSG-1, 11 June 1990
SGFS N 225	Resolutions of JTC1 Advisory Group, 11 June 1990
SGFS N 226	Liaison Statement to JTC1 on Multi-Part ISDN ISP Structures, 11 June 1990
SGFS N 228	Liaison Statement to JTC1 SGFS on the Inclusion of a Profile for MMS in the Taxonomy of Profiles TR 100000-2, 11 June 1990
SGFS N 229	Resolutions of the 3rd Regional Workshop Coordinating Committee Meeting; AOW - EWOS - NIST OIW, 11 June 1990
SGFS N 236	EWOS Organization and Activities, 11 June 1990
SGFS N 282	Resolutions of the 4th RWS-CC Meeting, 18-19 October 1990, 17 January 1991
SGFS N 300	List of documents (N 182 - N 300), Secretariat, 12 February 1991
SGFS N 373	Output from the 5th Regional Workshop Coordinating Committee (RWS-CC), March 18-19, 1991, 13 June 1991

SC21 SD-1	Report of the Secretariat to the Plenary Meeting of ISO/IEC JTC1 SC21, 5-6 June 1990, Seoul, Republic of Korea, SC21 Secretariat, 12 April 1990

	[SC21 N 4588] (provides terms of reference and points of contact for working groups)
SC21 SD-2	ISO/IEC JTC1 SC21 Programme of Work (POW) - Target Date Summary for All Active and Published Projects, SC21 Secretariat, April 1990
SC21 SD 7	Security Management Plan, 4 June 1990 [SC21 N 5130]
SC21 SD-8	SC21 Schedule of Meetings, 20 June 1991 [SC21 N 6261]
SC21 SD-9	Approved Commentaries on the Basic Reference Model for Open System Interconnection, OSI Reference Model Editor, July 1991 [SC21 N 6198]
CD xxxx♦	A Formal Description of the Transport Service Definition in Estelle
CD xxxx♦	A Formal Description of the Transport Protocol Specification in Estelle
CD xxxx	Transport Test Management Protocol (awaiting CD ballot)
CD xxxx♦	Transport Layer Security Protocol (awaiting CD ballot)
CD yyyyy	Network Layer Security (working draft)
CD xxxxx-2	Basic Reference Model of ODP - Part 2: Descriptive Model [SC21 N 6079]
WD xxxx	Information Resource Dictionary System (IRDS) - Design Support for SQL Applications (CD text expected January 1991)
WD xxxx	Information Resource Dictionary System (IRDS) - Export/Import (CD text expected November 1990)
WD xxxx	Information Resource Dictionary System (IRDS) - Extensions, July 1990 [SC21 N 5139] (CD text expected June 1992)
WD xxxx	Registration of System Titles (DP expected November 1990)
WD xxxx	Service and Protocol for Authentication Exchange Application Service Element (ASE), January 1990 [SC21 N 4110] [JTC1 N 767] (WD expected October 1990, CD expected June 1992; collaborative work with CCITT SG VII)
WD xxxx-1	Cryptographic Mechanisms for Key Management, Part 1: Key Management Overview [SC27/WG2]
WD xxxx-2	Cryptographic Mechanisms for Key Management, Part 2: Key Management Using Secret Key Techniques [SC27/WG2]
WD xxxx-3	Cryptographic Mechanisms for Key Management, Part 3: Key Management Using Public Key Techniques [SC27/WG2]
WD xxxx-4	Cryptographic Mechanisms for Key Management, Part 4: Key Management Using Public Key Register [SC27/WG2]
WD xxxxx	Applications with Multi-Parties [SC21 N 6197]
WD xxxxx-1	Security Exchange Application Service Element (ASE) Part 1: Model and Specification Framework, WG6, 3 June 1991 [SC21 N 6096]
WD xxxxx-2	Security Exchange Application Service Element (ASE) Part 2: Service Definition, WG6, 3 June 1991 [SC21 N 6096]
WD xxxxx-3	Security Exchange Application Service Element (ASE) Part 3: Protocol Specification, WG6, 3 June 1991 [SC21 N 6096]
WD xxxxx-4	Security Exchange Application Service Element (ASE) Part 4: PICS Proforma, WG6, 3 June 1991 [SC21 N 6096]
PDTR xxxx	Information Processing - Methodology and Guidelines for the Development of Application Layer Protocols, June 1990 [SC21 N 4903] (new work item of June 1988 failed but programme of work with CDTR is still active; status uncertain)

PDTR xxxx	ESTELLE Formal Description of ISO 8473 (awaiting PDTR ballot)
WDTR xxxx	Systems Management Tutorial, July 1990, SC21/WG4 [JTC1 N 957] [SC21 N 4942] (CCITT X.702)
WDTR xxxx, Ann A	Systems Management Tutorial - Annex A: Access Control, 30 May 1990 [SC21 N 4970]
WDTR xxxx	Application Layer Guidelines, November 1989 [SC21 N 3206, December 1988] (CD text expected in 1990)
WDTR xxxx	Tutorial on the Reference Model for Data Management (PDTR expected June 1992)
WDTR xxxx◆	Architectural Semantics for FDTs (new work item, October 1987) [SC21 N 2010]
WDTR xxxx◆	Information Processing Systems - Open Systems Interconnection - Remote Database Access (RDA) Tutorial, January 1989 [SC21 N 3343] (CD text expected June 1991)
WDTR xxxx	Catalogue of PICS Proforma Notations, July 1991 (joint work of WG1 and CCITT SG VII; meeting scheduled for February 1991) [SC21 N 6160]
EWOS/EGTP/91/12	Draft Taxonomy for Distributed Transaction Processing, EWOS, 13 February 1991
IST18 N 2694	Final Report on the Framework for Open Systems, July 1990
IST21 N 2361	UK Comment Accompanying Vote of Disapproval on CD 10728, Information Resource Dictionary System Services Interface, UK, 24 October 1990
IST21 N 2393	Proposals for Corrigenda to OSI Standards - Reprint from BSI News, November 1990
IST21 N 2478	Catalogue of Security Related Projects for consideration at the JTC 1 Workshop on Security 5-7 November 1990, 30 May 1990
IST21 N 2491	Change in Work Schedule, SC21 Secretariat, 7 January 1991
IST21 N 2499	Report on the Anaheim IRDS Services Interface Meetings, David JL Gradwell, 18 January 1991
IST21 N 2508	PICS Proforma Notations, 17 January 1991
IST21 N 2512	Resolutions of the 4th RWS-CC meeting, October 18-19, 1990, Tokyo, EWOS, 17 January 1991
IST21 N 2514	Information Technology - International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 1: Specification of ACSE, Presentation and Session Protocols for the use by FTAM, Project Editor, 17 January 1991
IST21 N 2531	Discussion Paper on the Nature of Protocol Profiles, BSI, 6 February 1991
IST21 N 2551	UK Response to SC21 N 5110 on the Technical Structure of Quality-of-Service (QOS) Architecture, February 1991
IST21 N 2552	Proposed UK Contribution on QOS, Joint Meeting on QOS, 29 January 1991
IST21 N 2589	Minutes of the 20th meeting of EWOS EGLL from October 8 to October 11, 1990, in Brussels, 1 February 1991
IST21 N 2594	Register of IST21 Documents, September 1990 - February 1991, 26 February 1991
IST21 N 2670	Prospective vs Traditional Standardization, 21 March 1991
IST21 N 2685	Access to Public and Private MHS (1988) Common Facilities MTS end-user to MTS end-user and MTA, 4 March 1991
IST21 N 2731	Proposed EN 41204, Simple File Transfer Service, 22 April 1991

IST21 N 2742	Information Technology - International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 2: Definition of document types, constraint sets and syntaxes, Project Editor, 17 January 1991
IST21 N 2743	Information Technology - International Standardized Profiles AFT nn-File Transfer, Access and Management - Part 3: AFT 11 - Simple File Transfer Service (unstructured), Project Editor, 17 January 1991
IST21 N 2744	A Mapping of the X Window System over and OSI Stack, EWOSEG VT, 15 April 1991
IST21 N 2754	Extension of M-IT-01 and M-IT-02 for the Open System Environment, European Workshop for Open Systems, EWOSTA9181, April 1991
IST21 N 2852	POSIX Security Call for New Work Items, SC22/WG15, June 1991
IST21 N 2860	EWOS Technical Guide Routeing in the Context of OSI, EWOS-EGLL9172, Final Draft, 27 May 1991
IST21 N 2765	EWOS Proposed Taxonomy for OSI-TP, 10 May 1991
IST21 N 2766	March 1991 Resolutions RWS-CC, 10 May 1991
IST21 N 2769	Summary of EWOS Contribution to JTC1 SGFS, June 1991, 10 May 1991
IST21 N 2770	AD HOC Meeting on an Open Systems Framework, 10 May 1991
IST21 N 2879	Status of ISO Work on OSI TP Standards, EWOS/EGTP/90/19r, 26 June 1991
IST21 N 2880	Interim Report on the Feasibility of Profiling Database Enquiry, EWOSPT N 014, June 1991
BSI 91/64912	Ad Hoc Meeting on PCTE, 14 June 1991
BSI 91/64913	Background Information on PCTE Standardization, ECMA, ECMA TC33, 12 April 1991
BSI 91/64914	ECMA PCTE, J. Dawes and H. Davis, ICL Secure Systems, March 1991
BSI 91/64915	Extract of PCTE Standards, ECMA, 28 February 1991
SC5 N 220	Interim Report of the TCCA Rapporteurs' Group of Time-Critical Communications Architecture and Systems, 15 April 1991
SC6 N 4053	End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with ISO 8473
SC6 N 4782	An Architectural Framework for Private Networks, Pre-Publication Version of ECMA TR 44, December 1987
SC6 N 5006	End System to Intermediate System Routing Exchange Protocol for Use in Conjunction with ISO 8208 (X.25/PLP), May 1988
SC6 N 5447	Liaison Statement to SC21/WG4 on Lower Layer Management, 13 October 1990
SC6 N 5784	General Principles for the Definition of Lower Layer Management, Second Draft, JTC1 SC6/WG2/WG4, April 1990
SC6 N 6219	Liaison to SC21 on Lower Layer Security, ISO/IEC/JTC1/SC6, 4 October 1990
SC6 N 6221	Draft Network Layer Security Protocol, SC6/WG2, 28 September 1990 (incomplete editor's Draft B)
SC6 N 6227	Lower Layer Security Guidelines, SC6/WG2/WG4, 28 September 1990
SC6 N 6285	Working Draft OSI Transport Layer Security Protocol, SC6/WG4, 28 September 1990

SC21 N 197	Concepts and Terminology for the Conceptual Schema and the Information Base, TC97/SC5, March 1982
SC21 N 236	Assessment Guidelines for Conceptual Schema Language Proposals, TC97/SC21/WG5-3, 31 August 1985
SC21 N 1889	ODP: Proposed Revised Text for the NWI on the Basic Reference Model of Open Distributed Processing, 29 April 1987
SC21 N 2409	Project File: November 1990, 21 November 1990
SC21 N 2507	ODP: Report on Topic 1 - The Problem of Distributed Processing, March 1988 [SC21/WG7]
SC21 N 2511	ODP: Definitions and Glossary - March 1988 Version, March 1988 [SC21/WG7]
SC21 N 2524	SC21/WG1 Overview - OSI Architecture, 29 January 1991
SC21 N 2525	IST/21 Project File: January 1991, 30 January 1991
SC21 N 2555	Work in Security within SC21, Gray Girling, 15 February 1991
SC21 N 2652	Security Features in International Standards Profiles (ISPs), E.J. Humphreys, Chair of IST33, 14 March 1991
SC21 N 3109	Architectural and Descriptive Issues Identified During the Workshop on Application Layer Standardization, December 1988 [SC21/WG1]
SC21 N 3122	Informal Guide for ISO/IEC JTC1 and CCITT Cooperation, 15 January 1989
SC21 N 3132	TTCN Operational Semantics, November 1988
SC21 N 3141	Response to SC21 N 2864, Issues Concerning the Requirements for Security Services in the Presentation Layer, November 1988 [SC21/WG1]
SC21 N 3167	Response to SC18 Liaison on Encryption, January 1989 [SC21/WG3]
SC21 N 3174	Working Document on ASN.1, Including Timetable, March 1989 [SC21/WG6]
SC21 N 3180	Possible CCR Extensions - Base Text, January 1989 [SC21/WG6]
SC21 N 3194	ODP: Working Document on Topic 2.3 - Framework of Abstractions, December 1988 [SC21/WG7]
SC21 N 3202	ODP: Recommendations of SC21/WG7, Sydney, 9 December 1988
SC21 N 3205	Proposed Modus Operandi and Programme of Work of SC21/WG6 ULA Rapporteur Group, December 1988 [SC21/WG6]
SC21 N 3207	Relationship Between Objects in Peer Open Systems, December 1988 [SC21/WG6]
SC21 N 3208	Requirements for More efficient Use of Application Associations, December 1988 [SC21/WG6]
SC21 N 3209	Upper Layer Security Model, July 1989 (WD expected October 1990 and CD June 1991; collaborative work with CCITT SG VIII)
SC21 N 3266	Guide for Open Systems Security, December 1988 [SC21/WG1]
SC21 N 3267	Plan for Work on Security in SC21, December 1988 [SC21/WG1]
SC21 N 3283	Working Draft for Lower-Layer Security Model, December 1988 [SC21/WG1]
SC21 N 3288	ODP: Working Document on Topic 2.2 - Properties and Design Freedoms, December 1988 [SC21/WG7]
SC21 N 3307	WG4 Architecture Issues List, December 1988 [SC21/WG4]
SC21 N 3311♦	Configuration Management Overview, December 1988 [SC21/WG4]
SC21 N 3316	Access Control for OSI Management and the Directory, December 1988 [SC21/WG4]
SC21 N 3317	Working Document on Extended Information Models, December 1988 [SC21/WG4]
SC21 N 3318	Working Document on the Directory Schema, December 1988 [SC21/WG4]

SC21 N 3319	Working Document on Replication and Knowledge Distribution, December 1988 [SC21/WG4]
SC21 N 3320	Working Document on Access Control, December 1988 [SC21/WG4]
SC21 N 3321	Working Document on Enhanced Search, December 1988 [SC21/WG4]
SC21 N 3322	Working Document on Attribute Classes, December 1988 [SC21/WG4]
SC21 N 3323	Request for National Body and CCITT Member Contributions on Directory PICS Proforma, December 1988 [SC21/WG4]
SC21 N 3337	Security Management Domain and Security Policies, December 1988 [SC21/WG4]
SC21 N 3344	IRDS Rapporteur Group Position on Need for IRDS Specialization for RDA, April 1989 [SC21/WG3]
SC21 N 3346	RDA Use of Remote Operation Notation of ROSE, December 1988 [SC21/WG3]
SC21 N 3351	RDA Requirements for CCR, December 1988 [SC21/WG3]
SC21 N 3352	Harmonization of RDA and TP, December 1988 [SC21/WG3]
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SC21 N 3369	Terminal Management (TM) Issues List, February 1989 [SC21/WG5]
SC21 N 3372	Sharing an Association Between FTAM and Other ASE, February 1989 [SC21/WG5]
SC21 N 3381	Statement on TM Strategic Direction, February 1989 [SC21/WG5]
SC21 N 3383	Relationship Between TM and User Interfaces, February 1989 [SC21/WG5]
SC21 N 3665	Specific Partial Abstract Test Suite (ATS) for Response Tests (CD text expected in October 1992; DIS in October 1993; IS in October 1994)
SC21 N 3666	Abstract Test Suite (ATS) for CS Test Method (WD text expected in June 1992; CD in October 1992; DIS in October 1993; IS in October 1994)
SC21 N 3674	Information Processing Systems - International Standardized Profiles - Directory of ISPs and Profiles Contained Therein, June 1989
SC21 N 3675	Information Processing Systems - International Standardized Profiles - ISP Approval and Maintenance Process, June 1989
SC21 N 3678	Information Processing Systems - International Standardized Profiles - Proposed New AMH Taxonomy, June 1989
SC21 N 3711	Requirements for Multipeer Data Transmission, July 1989
SC21 N 3733	Access Control for OSI Applications, July 1989
SC21 N 3801	Support Environment for Open Distributed Processing, ECMA, September 1989
SC21 N 3806	Request for New Question on Conceptual Schema Standardization, September 1989
SC21 N 3903	Modelling, Specification, Use, and Role of Conceptual Schemas, October 1989
SC21 N 3906	Final Report to SC21 in Florence on the Reassessment of Project JTC 1.21.9.1 on Multipeer Data Transmission, October 1989
SC21 N 3925	Liaison Statement to JTC1 SC21 from JTC1 SWG-EDI, JTC1 SWG-EDI, 19 October 1989
SC21 N 3930	Liaison Statement from JTC1/SC18 to JTC1/SC21/WG5 on Comments on Terminal Management, SC18/WG4, 19 October 1989
SC21 N 3991	Security Exchange Service Element, CCITT Q19/VII(DAF), November 1989 (CD text in SC21/WG6 expected in 1992)
SC21 N 4002	Extended Application Layer Structure, ANSI Contribution to SC21/WG6, 19 October 1989
SC21 N 4019	ODP: Topics List - November 1989 Version - for the Basic Reference Model of Open Distributed Processing, 8 November 1989

SC21 N 4020	ODP: List of Open and Resolved Issues - November 1989 Version, 11 December 1989
SC21 N 4021	ODP: Document Register and Bibliography - November 1989 Version, 11 December 1989
SC21 N 4022	ODP: Working Document on Topic 4.1 - Structures and Functions, 11 December 1989 [superceded by SC21 N 4885]
SC21 N 4023	ODP: Working Document on Topic 6.1 - Modelling Techniques and Their Use in ODP, 11 December 1989
SC21 N 4024	ODP: Working Document on Topic 6.2 - Formalisms and Specifications, 11 December 1989
SC21 N 4025	ODP: Working Document on Topic 8.1 - Draft Basic Reference Model of Open Distributed Processing, 11 December 1989
SC21 N 4026	ODP: Recommendations of SC21/WG7, Florence, 11 December 1939
SC21 N 4027	ODP: Meeting Minutes of the Florence Working Group Meeting of WG7, 11 December 1989
SC21 N 4028	ODP: SC21/WG7 Convener's Report to SC21 Plenary Meeting 11 December 1989
SC21 N 4029	ODP: Liaison Statement to JTC1/TSG-1 on IAP, [illegible] December 1989
SC21 N 4030	ODP: Cooperation between SC21/WG7 and CCITT SG VII (Q19/DAF), 11 December 1989
SC21 N 4031	ODP: Session Report on Joint Meeting on FDT, 11 December 1989
SC21 N 4032	ODP: Liaison Statement to JTC1/SWG-EDI on EDI Modelling, 11 December 1989
SC21 N 4033	ODP: Proposal for Future Cooperation Between SC21/WG6 and SC21/WG7 on ULA and ODP, 11 December 1989
SC21 N 4058	State Tables for CMIP, January 1990
SC21 N 4077♦	Fault Management Working Document, SC21/WG4, December 1989
SC21 N 4085♦	Accounting Management Working Document, Third Version, SC21/WG4, November 1989
SC21 N 4091♦	OSI Security Management Working Document, 15 November 1989
SC21 N 4106	Application Layer Recover, January 1990 (new work item; CD text expected June 1991)
SC21 N 4107	Modelling for Communications Aspects of Distributed Applications, January 1990 [JTC1 N 765] (new work item; CD text expected June 1991)
SC21 N 4108	Management Information in the Upper Layers, January 1990 (new work item; CD expected June 1991)
SC21 N 4162	Proposal for a NWI for Enhancement of FTAM Services to Satisfy Additional User Requirements, December 1989
SC21 N 4167	TP Heuristic Decisions, January 1990 [PDAMs dependent on National Body input]
SC21 N 4168	TP Commitment Optimizations, January 1990 [PDAMs expected June 1991]
SC21 N 4170	TP Dialogue Recovery and User Suspension of a Dialogue, January 1990 [PDAMs expected June 1992]
SC21 N 4171	TP Savepoints, January 1990 [NWI not accepted]
SC21 N 4184	Request for National Body Comment on Security Enhancements to FTAM, SC21/WG5, November 1989
SC21 N 4188	Response to SC18/WG4 N 1183, Comments on Terminal Management, and SC18/WG3 and CCITT SG VII(Q27) Liaison Statement on Terminal Management, SC21/WG5, December 1989

SC21 N 4188	Response to SC18/WG4 N 1183, Comments on Terminal Management, and SC18/WG3 and CCITT SG VII(Q27) Liaison Statement on Terminal Management, SC21/WG5, December 1989
SC21 N 4189	Comments on the Integration of X-Windows into the OSI Environment, December 1989
SC21 N 4192	Proposed FTAM Document Type to Support CGM, SC21/WG5, December 1989
SC21 N 4195	Draft WG3 Position on Conceptual Schema Question, February 1990
SC21 N 4199	Liaison Statement to JTC1/SC1 on SC21/WG3 Terminology, contains the Reference Model on Data Management (8 August 1989), February 1990
SC21 N 4199	Liaison Statement to JTC1/SC21 on SC21/WG3 Terminology, SC21/WG3, February 1990
SC21 N 4215	Formal Methods in Conformance Testing (new work item, January 1990)
SC21 N 4279	CCR Conformance Test Suite, January 1990 (new work item) (WD text expected June 1992, CD text June 1993)
SC21 N 4280	Proposed New Work Item: Conceptual Data Modelling Facility, SC21/WG3, February 1990
SC21 N 4354	Topics Proposed for Discussion at the JTC1 Workshop on Distributed Applications, Phoenix, March 1990, U.K. Contribution, January 1990
SC21 N 4383	Development of the Extended Information Model, January 1990
SC21 N 4472	Liaison Statement from JTC1/SC18 to JTC1/SC21 on Changes to ASN.1, SC18/WG3 (title is in error--changes are for ODA, ISO 8613), 22 February 1990
SC21 N 4511	U.S. Comments on Conceptual Schema, ANSI, 15 March 1990
SC21 N 4519	Clarification of ALS Modelling Concepts, Workshop on Distributed Applications, 18 April 1990
SC21 N 4520	Issues for Consideration by Joint ULA/ODP Meeting, Seoul, May/June 1990, Workshop on Distributed Applications, 18 April 1990
SC21 N 4523	Modelling of Application Program Interfaces and Remote Procedure Calls, Distributed Applications Workshop, 2 April 1990
SC21 N 4524	Consideration of the Data Management Component of Application Standards, Workshop of Distributed Applications, 23 April 1990
SC21 N 4526	Application Layer Security Considerations, Workshop of Distributed Applications, 18 April 1990
SC21 N 4564	ODP: Liaison Statement to SC21/WG7 on Relationship of DAF Architecture/Infrastructure with ODP Topic 4 - Functions and Interfaces, CCITT SG VII, March 1990
SC21 N 4593	Metadata Use and Standards for Managing Metadata, ANSI, 4 April 1990
SC21 N 4603	Position on Reassessment of JTM Full Class Protocol, AFNOR, March 1990
SC21 N 4641	U.S. Position on JTM Reassessment, March 1990
SC21 N 4647	Requirements for Service Conventions, May 1990
SC21 N 4648	Security and Security Exchange Information, 28 February 1990, Canadian Contribution to SC21/WG6
SC21 N 4655	Architectural Semantics for ODP - Reassessment Report, SC21/WG7, April 1990
SC21 N 4672	Liaison Statement on Character Internationalization, SC21/WG3 on Database Language Extended SQL, 26 May 1990
SC21 N 4674	Liaison Statement Regarding Common Application Interfaces for the Telematic Services, CCITT SG I, 23 May 1990
SC21 N 4679	Reassessment of Project 1.21.13.03 (JTM Full Class), SC21, 10 June 1990

SC21 N 4716	Initial List of Planned PDISPs, 30 April 1990
SC21 N 4728	Collections of Definitions of OSI Vocabulary, SC21, April 1990
SC21 N 4744	Development of the DSA Information Model: Extended Distribution Knowledge Model, SC21/WG4, May 1990
SC21 N 4758	Request to ISO/IEC SC21 from OSF for Establishment of Liaison Relationship, 4 May 1990
SC21 N 4763	On-Going Multipeer Projects Within JTC1, ANSI, May 1990
SC21 N 4764	Progression of Association Pools, ANSI, 9 May 1990
SC21 N 4766	U.S. Response to SC21/WG6 N 770 on Requirements for Extended ALS, ANSI, May 1990
SC21 N 4767	US Response to SC21/WG6 N 7889 on Requirements for RPC Interface Definition Notation, 11 May 1990
SC21 N 4769	Discussion of Initial Schema Information Acquisition for Directory, SC21/WG4, May 1990
SC21 N 4770	Short-Form Names for Directory, SC21/WG4, May 1990
SC21 N 4771	US Positions on SC21 N 433, Working Draft on the Schema, SC21/WG4, May 1990
SC21 N 4773	Development of the DSA Information Model: Basic Distribution Knowledge, SC21/WG4, May 1990
SC21 N 4799	Letter for Information on Disposition of EDIMS Use of Directory, 21 May 1990
SC21 N 4801	Liaison Statement to SC21 on Joint Efforts Between SG VII(Q20) and SG I(Q16), CCITT SG I(Q.16), 21 May 1990
SC21 N 4802	Liaison Statement to SC21 on Comments on Short Form Names and Other Name Forms, CCITT SG I(Q.16), 21 May 1990
SC21 N 4803	Publication of Directory Schema and Other Registered Object Definitions, Canada, 2 May 1990
SC21 N 4804	Proposed DIT Structure Rule Definition, 10 May 1990
SC21 N 4806	Use of External Data Transfer Systems for Shadow Updates, 10 May 1990
SC21 N 4833	Report to JTC1 from SC27 on Security Techniques, SC27 Secretariat, 21 May 1990 [SC27 N 94, 3 May 1990]
SC21 N 4834	Liaison Statement from SC27 to JTC1 Advisory Group, SC27 Secretariat, 21 May 1990 [SC27 N 93, 3 May 1990]
SC21 N 4835	Report of the First Plenary Meeting of SC27 at Stockholm, 24-26 April 1990, SC27 Secretariat, 21 May 1990 [SC27 N 92, 1 May 1990]
SC21 N 4836	Resolutions Taken at the First Plenary Meeting of SC27 at Stockholm, 24-26 April 1990, 21 May 1990 [SC27 N 94, 3 May 1990]
SC21 N 4875	Recommendation on SQL2 Progress ISO 9075 Revised, 31 May 1990
SC21 N 4885	ODP: Working Document in Topic 4.3 - Function and Interface Definitions, 13 July 1990
SC21 N 4903	Methodology and Guidelines for the Development of Application Layer Standards, SC21/WG6, June 1990
SC21 N 4904	Request for Comment on Characteristics of an Application Service Element and Application Service Object, SC21/WG6, May 1990
SC21 N 4905	Request for Comment on Introduction of a New Relationship in ALS, SC21/WG6, June 1990
SC21 N 4906	Upper Layer Management - Call for Contributions, SC21/WG6, June 1990
SC21 N 4908	Liaison to CCITT SG VII(Q19,Q25) on ULA Topics, SC21/WG6, June 1990

SC21 N 4918	Question on Standardization of Directory API, July 1990
SC21 N 4922	Information on Distributed Entries, SC21/WG4, July 1990
SC21 N 4924	Extensions to Directory Abstract Service, Working Draft, SC21/WG4, July 1990
SC21 N 4925	Liaison to SC22/WG11 Concerning Remote Procedure Call Interface Definition Notation (IDN), June 1990
SC21 N 4926	Liaison to CCITT SG VII(Q19) on DAF, SC21/WG6, June 1990
SC21 N 4927	Working Draft, Information Processing Systems - Open Systems Interconnection - Remote Procedure Call, SC21/WG6, 1 June 1990
SC21 N 4928	Remote Procedure Call Definitions and Requirements, SC21/WG6, June 1990
SC21 N 4939	Recommendations of the Seventh SC21/WG4 Meeting, Seoul, 22-31 May 1990, May 1990
SC21 N 4940	SC21/WG4 Convenor's Report to ISO/IEC JTC1/SC21 Plenary Meeting, Seoul, 5-6 June 1990, 5 June 1990
SC21 N 4941	Recommendations of the Seventh SC21/WG4 Meeting, Seoul, 22-31 May 1990, May 1990
SC21 N 4943	Extended Systems Management Architecture, SC21/WG4, July 1990 [JTC1 N 958] (new work item; planned to be an amendment to DIS 10040)
SC21 N 4944	Generic Managed Objects, SC21/WG4, July 1990 (new work item) [It has yet to be decided whether this work will result in an addendum to 10165-2, a new part to 10165, or a standard in its own right].
SC21 N 4945	Definition of a Management Information Register and Registration Procedures, SC21/WG4, July 1990 (new work item)
SC21 N 4946	Requirements and Guidelines for Managed Object Conformance Statement (MOCS) Proformas, SC21/WG4, July 1990 (new work item)
SC21 N 4947	Formal Descriptions of CMIP, SC21/WG4, July 1990 (new work item)
SC21 N 4948	Systems Management Relationship Model, SC21/WG4, July 1990 (new work item; expected to use entity-relationship modelling)
SC21 N 4949	Systems Management: Response Time Monitoring Function, SC21/WG4, July 1990 (new work item)
SC21 N 4951	Test Suites for OSI Directory, SC21/WG4, July 1990 (new work item)
SC21 N 4953	Time Management: Representation of Time, SC21/WG4, July 1990
SC21 N 4960	Generic Managed Objects, Working Draft, SC21/WG4, July 1990
SC21 N 4961	Request for Contributions to Progress Work on the Definition of State Tables for CMIP, May 1990
SC21 N 4968	Synchronization Across Multiple Managed Objects, SC21/WG4, July 1990
SC21 N 4969	Call for National Body Contributions on Time Management, SC21/WG4, May 1990
SC21 N 4973	The Use of System Title by OSI Management, SC21/WG4, July 1990
SC21 N 4974	Use of Global Naming for Identification of Managed Objects, SC21/WG4, July 1990
SC21 N 4975	A General Model for Relationship Management, SC21/WG4, 31 May 1990
SC21 N 4977	Use of Action to Invoke State Changes, SC21/WG4, July 1990
SC21 N 4979	Request for National Body Comment on the Need for an Access Control Information Management Function, SC21/WG4, May 1990
SC21 N 4980	Security Audit Framework Working Document, SC21/WG4, July 1990
SC21 N 4981 ♦	Performance Management Working Document, Sixth Working Draft, 4 July 1990
SC21 N 4982	WG4 Systems Management Issues, SC21/WG4, July 1990

SC21 N 5001	Upper Layers Security Model, Third Working Draft, SC21/WG6, 5 June 1990 (CD text expected in 1991)
SC21 N 5002	Commencement of Work on Security ASEs, SC21/WG6, 31 May 1990
SC21 N 5003	Distributed Applications Security Modelling and Infrastructure, SC21/WG6, July 1991
SC21 N 5011	Modelling Recovery in the Application Layer, SC21/WG6, 1 June 1990 (new work item; CD text expected June 1991)
SC21 N 5012	Proposed Draft Amendment 1 to ALS on Extended Application Layer Structure, ISO/IEC JTC WG6 ULA, November 1990
SC21 N 5014	Liaison Statement to CCITT SG VII (Q.23) on Collaborative Work on OSI Registration, 6 June 1990
SC21 N 5016	Meeting Report for SC21/WG1/WG4/WG6/WG7 Joint Meeting on Service Conventions, ODP, and ULA on 29 May 1990, SC21, June 1990
SC21 N 5017	Relationship Between Concepts and Models for OSI and ODP, SC21/WG6, July 1990
SC21 N 5051	Working Document on ASN.1 Extensions, Character Sets, Version 3, SC21/WG6, 19 July 1990 supercedes N 4141]
SC21 N 5052	Working Document on ASN.1 Extensions, Table Types and Functions, Version 4, SC21/WG6, 11 July 1990 supercedes N 4143]
SC21 N 5053	Working Document on ASN.1 Extensions, Machine Processibility, Version 3, SC21/WG6, 31 May 1990 supercedes N 4140]
SC21 N 5054	Working Document on Basic Connection-Oriented Presentation Service Definition - Presentation Service to Give Confidentiality and Integrity Protection, SC21/WG6, 11 July 1990
SC21 N 5055	Working Document on ASN.1 Extensions, Miscellaneous Enhancements, Version 3, SC21/WG6, 31 May 1990 supercedes N 4139]
SC21 N 5061	Handling of Exception Cases in ASN.1, SC21/WG6, 11 July 1990
SC21 N 5063	Liaison on Handling of Character Sets in ASN.1, JTC1/SC2, 14 June 1990
SC21 N 5064	Working Document on Basic Connection-Oriented Presentation Protocol Specification - Amendment to the Presentation Protocol to Give Confidentiality and Integrity Protection, SC21/WG6, 11 July 1990
SC21 N 5069	Call for Comments on Technical Approval for Development of ASN.1 Work Plan, SC21/WG6, 11 July 1990
SC21 N 5071	Recommendations Approved by SC21/WG1 at its Seoul Meeting, 23-31 May 1990, SC21/WG1, May 1990
SC21 N 5072	List of Output Documents of SC21/WG1 Meeting, Seoul, 23-31 May 1990, SC21/WG1, July 1990
SC21 N 5073	Final Answer to Q1/30.5 on Definition of the Term "Quality of Service," SC21/WG1, May 1990
SC21 N 5074	Final Answer to Q1/330.6 on Relay, Routing, and Network Management, SC21/WG1, May 1990
SC21 N 5075	Protocol Profile Testing Methodology, Second Working Draft, SC21/WG1, July 1990
SC21 N 5078	Catalogue of PICS Proforma Notations, SC21/WG1, July 1990
SC21 N 5079	Draft Answer to Q1/63.1 on Conformance to Objects in the Context of OSI Management, SC21/WG1, May 1990
SC21 N 5080	Call for Contributions on OSI Management Conformance Issues, SC21/WG1, July 1990

SC21 N 5081	Draft Answer to Q1/61 on Consistency Among ISO Standards Related to the OSI Reference Model, May 1990
SC21 N 5093	Status and Method of Operation for the Reference Model Revision, SC21/WG1, May 1990
SC21 N 5095	Liaison to SC6 on Revision of the Reference Model, May 1990
SC21 N 5096	Liaison to CCITT SG VII on Revision of the Reference Model, June 1990
SC21 N 5099	Liaison Statement to CCITT SG VII(Q.25) on Service Conventions, SC21/WG1, May 1990
SC21 N 5105	Final Answer to Q1/56.6.1 on Positioning of Circuit Switched Networks, SC21/WG1, May 1990
SC21 N 5107	SC21/WG3 (Database) Convenor's Report to Plenary, May 1990
SC21 N 5108 ADD	Report of the Conformance Testing Meeting, Held in Seoul, 22-30 May 1990, December 1990
SC21 N 5109	Liaison Statement to CCITT SG VII(Q23) on Naming and Addressing, SC21/WG1, July 1990
SC21 N 5110	Call to National Bodies and Liaison Organizations for Contributions on Technical Structure of Quality of Service (QoS) Architecture, May 1990
SC21 N 5112	Discussion Paper on Formal Methods in Conformance Testing, SC21/WG1, July 1990
SC21 N 5116	Architectural Semantics for FDTs, Working Draft, SC21/WG1, July 1990
SC21 N 5117	Multi-Party Testing for MHS, SC21/WG1, July 1990
SC21 N 5131	Recommendations of the SC21/WG6 Meeting, 23 May - 1 June 1990, Seoul, SC21/WG6, June 1990
SC21 N 5136	Recommendations of SC21/WG3 Meeting in Seoul, May/June 1990, SC21/WG3, 19 June 1990
SC21 N 5137	Data Management Export/Import for SQL and IRDS, SC21/WG3, October 1990 (new work item)
SC21 N 5138	RDA Support for Shared DBL Statements, SC21/WG3, October 1990 (new work item; rapporteur meeting January 1991)
SC21 N 5139	IRDS Extensions, SC21/WG3, July 1990 (new work item)
SC21 N 5154	Recommendations of the SC21/WG5 Meeting, Seoul, 24 May - 1 June 1990, SC21/WG5, June 1990
SC21 N 5155	Enhancement of FTAM Security Services, New Work Item Proposal, SC21/WG5, July 1990 [PDAM expected January 1992]
SC21 N 5156	TP Sub-Transactions, New Work Item Proposal, SC21/WG5, July 1990
SC21 N 5157	TP Separate Data and Commit Associations, New Work Item Proposal, SC21/WG5, July 1990
SC21 N 5158	Conformance Test Suite for the VT Protocol, July 1990 [JTC1 N 770] (new work item; CD text expected November 1990)
SC21 N 5162	WD xxxx, Information Processing Systems - Open systems Interconnection Interconnection - Conformance Test Suite for the VT Protocol - Test Suite and Test Procedures, June 1990
SC21 N 5164	Planned Work Schedule for FTAM, SC21/WG5, June 1990
SC21 N 5165	FTAM Constraint Set and Document Types for CGM, SC21/WG5, June 1990
SC21 N 5170	OSI TP Association Management - Statement of Requirements, SC21/WG5, June 1990
SC21 N 5171	OSI TP Security - Statement of Requirements, SC21/WG5, June 1990

SC21 N 5172	Combined Use of RPC and OSI TP, SC21/WG5, June 1990
SC21 N 5173	Working Draft Unstructured Data Transfer (UDT) for TP, SC21/WG5, May 1990
SC21 N 5176	OSI TP Security, New Work Item, June 1990
SC21 N 5177	OSI TP Association Management - Revised New Work Item, SC21/WG5, June 1990
SC21 N 5179	Proposed Replacement Text for the NWI Proposal on Commitment Optimizations in SC21 N 4168 (JTC1 N 631), SC21/WG5, June 1990
SC21 N 5183	Combined Use of CMISE and OSI TP, SC21/WG5, June 1990
SC21 N 5184	Queued Data Transfer for TP, SC21/WG5, May 1990
SC21 N 5189	Liaison Statement to JTC1/SWG-EDI on EDIFACT Document Types for FTAM, SC21/WG5, June 1990
SC21 N 5193	Conceptual Schema HOD/C Meeting report Held on 31 May 1990 in Seoul, July 1990
SC21 N 5194	Resolutions of the Fourth Plenary Meeting of SC21, 5 June 1990, Seoul, SC21, 5 June 1990
SC21 N 5196	Report of the Special Meeting on User Requirements, SC21, 7 June 1990
SC21 N 5197	Report of the Standards Maintenance Group, SC21, 4 June 1990
SC21 N 5203	SC21/WG1 Convenor's Report to SC21 Plenary Meeting, Seoul, 5-6 June 1990, SC21/WG1, 3 June 1990
SC21 N 5205	ISO/IEC JTC1/SC21 WG1 Programme of Work, May 1990
SC21 N 5219	Draft Management Guidelines for SC21, Rapporteur for Strategic Planning, July 1990
SC21 N 5228	Report of the ISO/IEC JTC1/SC21 Plenary Meeting, 5 June 1990, Seoul, Korea, 30 July 1990
SC21 N 5228	Proposed Technical Corrigenda to ISO 9595 and ISO 9596
SC21 N 5229	Report of the JTC1/SC21 Plenary Meeting, 5 June 1990, Seoul, Republic of Korea
SC21 N 5337	EWOS Organizations and Activities, 9 October 1990, EWOS
SC21 N 5346	U.S. Contribution on the Layer Security Model (ULSM), [SC21 N 5001], October 1990
SC21 N 5347	U.S. Contribution on the Security Frameworks Overview [SC21 N 5044, November 1990]
SC21 N 5348	U.S. Contribution on the Access Control Framework [SC21 N 5045, November 1990]
SC21 N 5349	U.S. Contribution on the Non-Repudiation Framework [SC21 N 5046, November 1990]
SC21 N 5426	Directory Implementor's Guide - Editor, Version 3, ISO/IEC JTC1, 7 November 1990
SC21 N 5437	Proposal to Merge Working Set and Definition Working Set, 9 November 1990
SC21 N 5439	Proposed Amendment to CD 10728 to Cover Error States, 9 November 1990
SC21 N 5438	CD 10728 Clause 6, Proposed Revision 1, 9 November 1990
SC21 N 5448	Outline Working Draft for Part 1 of Generic Security Exchange ASE Definition, ISO/IEC, 30 October 1990
SC21 N 5502	Liaison Concerning Application Context Negotiation During Association Establishment, November 1990
SC21 N 5503	Response to Liaison Statement SC21 N 5453 on ULA Issues Arising on Security Work, November 1990

SC21 N 5504	Response to Liaison Statement to WG6 ULA and Upper Layer Security Groups (SC21/WG6 N 906), November 1990
SC21 N 5505	Liaison to CCITT Q23/VII and Q19/VII, ISO/IEC JTC WG6 ULA, November 1990
SC21 N 5545	Working Draft Input on Scheduling for Management Functions, 12-23 November 1990
SC21 N 5547	Liaison Statement from SC21/WG4 Testing Management Working Group to SC21/WG4 Extended Architecture, 12-23 November 1990
SC21 N 5548	Issues Concerning the Management Information Model and GDMO, 12-23 November 1990
SC21 N 5551	Work Plan for Managed Objects Standardization, 11 November 1990
SC21 N 5555	Liaison Statement to ISO/IEC JTC 1/SC21 on Lower Layer Security, SC 6, 3 January 1991
SC21 N 5557	Liaison Statement to ISO/IEC JTC1/SC21/WG1 on SC6 PICS Proforma Guidelines, SC6, 3 January 1991
SC21 N 5560	Liaison Statement to WG4 Concerning SMI-related Issues, SC6, 3 January 1991
SC21 N 5564	Proposal for a New Work Item: ODP Trader - A Standard to Define the Role and Function of the Trader in Open Distributed Processing (ODP), 31 January 1991
SC21 N 5572	Report of the Ad Hoc CCIR/CCITT Experts Group Meeting on ISDN Satellite Matters 5-9 November 1990, Geneva, 7 January 1991
SC21 N 5575	Request for National Body Comment, SC21/WG 1/CCITT, 7 January 1991
SC21 N 5576	Rapporteur's Report of the SC21/WG 1/CCITT Collaborative Meeting on Security Frameworks, 7 January 1991
SC21 N 5580	New Area of Work for SC27/WG1 on IT Security Information Objects, 7 January 1991
SC21 N 5581	New Area of Work for SC27/WG1 on IT Security Terminology, 7 January 1991
SC21 N 5584	Information Technology - Open Systems Interconnection - Remote Procedure Call, Second Working Draft, SC21/WG6, 7 January 1991.
SC21 N 5585	Call for Comment on RPC Bindings in the Computational Model, SC21/WG6, 7 January 1991.
SC21 N 5586	Call for Comment on the Nature of the OSI RPC Service Boundary and Service Provider, SC21/WG6, 7 January 1991.
SC21 N 5587	Call for Comment on RPC Exception Model, SC21/WG6, 7 January 1991.
SC21 N 5588	Call for Comment on OSI RPC Interface Definition Notation (IDN), SC21/WG6, 7 January 1991.
SC21 N 5590	Temporary Working Definitions for (RPC) Client and Server, SC21/WG6, 7 January 1991.
SC21 N 5593	The Role of the Extended Application Layer Structure in the Standardization of RPC, ECMA, 7 January 1991.
SC21 N 5596	Multiple Outstanding RPC Calls, ECMA, 7 January 1991.
SC21 N 5597	RPC Context Handles, ECMA, 7 January 1991
SC21 N 5599	Notice of and Draft Agenda for the ISO/IEC JTC1/SC21 Meeting, 4 & 5 June 1991, Arles, France, SC21 Secretariat, 12 February 1991
SC21 N 5605	Subcommittee Report to the ISO/IEC JTC 1 Advisory Group Meeting, 19-21 February 1991, Washington, D.C., USA, 13 January 1991
SC21 N 5635	Report of the Special Working Group on a Conceptual Model for Electronic Data Interchange Standards and Services (SWG-EDI), 23 January 1991

SC21 N 5657	Liaison Statements from CCITT SG VII to SC21/WG1 on Various Topics (conformance testing, OSI Reference Model regarding ISDN, OSI naming and addressing), 1 February 1991
SC21 N 5682	Contribution from WG11, Binding Techniques for Languages, 5 February 1991
SC21 N 5687	Management Information Registration Procedure, Working Draft, 14 February 1991
SC21 N 5707	Position Statement on PICS Notations, SGFS, 1 March 1991
SC21 N 5731	Progression of the Upper Layers Security Standards, Canada, 4 April 1991
SC21 N 5732	Use of Presentation Layer in Providing Confidentiality/Integrity, Canada, 4 April 1991
SC21 N 5733	Proposed ASN.1 Useful Type to Support Presentation Layer Confidentiality/Integrity, Canada, 4 April 1991
SC21 N 5734	Proposed Working Draft for Part 2 of Generic Security Exchange ASE Definition, Canada, 4 April 1991
SC21 N 5756	The Proliferation of Managed Objects, UK, March 1991
SC21 N 5757	Work on Security Within SC21, UK, March 1991
SC21 N 5758	Discussion Paper on Conformance and Registration, BSI, March 1991
SC21 N 5764	Information Retrieval, Transfer and Management for USA (ANSI), 23 April 1991
SC21 N 5803	Extended Relationship Management, USA, 28 March 1991
SC21 N 5815	A General Model for Managed Object Relationships, Canada, 28 March 1991
SC21 N 5816	Position on RPC Modelling, ECMA, 28 March 1991
SC21 N 5817	Binding Concepts Within RPC, ECMA, 28 March 1991
SC21 N 5818	Proposal for RPC Service Definition and Protocol Specification Parts, ECMA, 28 March 1991
SC21 N 5819	Modelling Rationale for OSI RPC, ECMA, 28 March 1991
SC21 N 5821	Contribution on the [RPC] Computation Model, ECMA, 28 March 1991
SC21 N 5822	Proposal for the Use of the XALS in the Standardization of RPC, ECMA, 28 March 1991
SC21 N 5826	EWOS Working Document on Behaviour of DSAs for Distributed Operations, EWOS/EGDIR/91/A/713, 3 April 1991
SC21 N 5830	SC21 Standards Maintenance, AFNOR, 3 April 1991
SC21 N 5833	TP/CCR Extensions - Proposed Restructure for Future Work, USA, 3 April 1991
SC21 N 5835	Discussion Paper on Association Pools as an Extension of ACSE, WG5, 4 April 1991
SC21 N 5836	USA Discussion Paper on Subtransactions, 4 April 1991
SC21 N 5840	Comments on the Relationship Between Concepts and Models for OSI and ODP, USA, 3 April 1991
SC21 N 5845	Questions and Issues Concerning Combined Use of CMISE and TP, USA, 4 April 1991
SC21 N 5849	USA Requirements to Reactivate the Multipeer Data Transmission Project (JTC 1.21.09.01), USA, 4 April 1991
SC21 N 5851	USA Contribution to SC21 on the Conceptual Schema Topic, USA, 4 April 1991
SC21 N 5856	Discussion Paper on Multi-Protocol Testing, SC21/WG 1 and CCITT SG VII Collaborative Meeting on Conformance, Phoenix, 7-14 February 1991, 5 April 1991
SC21 N 5891	Contribution to the New Work Item: Management Information Register and Registration Procedures, Germany, 16 April 1991

SC21 N 5903	Presentation Connection-Oriented Abstract Test Suite (ATS), Common Partial ATS (CD expected in June 1992; DIS in June 1993; IS in June 1994)
SC21 N 5904	Liaison Statement to JTC 1/SC 18, SC21 and SC 27 - Tracking of Existing and New Security Related Work Items, ISO/TC 68/SC 2, 23 April 1991
SC21 N 5933	Conventions for the Definition of 0SI Services, CD June 1990; DIS March 1991; IS expected March 1992
SC21 N 5934	Collection of Definitions of OSI Vocabulary (April 1991 Version), Rapporteur on Q17: OSI Vocabulary, 12 June 1991
SC21 N 5997	USA Position on Use of RTSE by SC21 Standards, 12 June 1991
SC21 N 6002	Liaison to SC21 on Directory's Use of ISO 9066 (ROSE), WG4, 12 June 1991
SC21 N 6006	Use of Systems Management for Administration of the Directory, WG4, JTC1 N 1440, 3 July 1991 (new work item)
SC21 N 6007	FTAM Document Type for Directory, WG4, May 1991 (new proposal) (WD status projected for June 1992; CD November 1992, IS June 1994)
SC21 N 6017	Comments on Standardization of Application Programmatic (sic) Interfaces, WG4, May 1991
SC21 N 6018	Resolutions of the Eighth SC21/WG4 Meeting, Arles, 20-27 May 1991, 20 June 1991
SC21 N 6019	Minutes of the Eighth SC21/WG4 Meeting, Arles, 20-27 May 1991, May 1991
SC21 N 6020	SC21/WG4 Convenor's Report to the ISO/IEC JTC1/SC21 Plenary Meeting, Arles, June 1991, 20 June 1991
SC21 N 6023	Work Plan for SC21/WG4 Systems Management, 20 June 1991
SC21 N 6029	Proposal for the Establishment of a Managed Object Advisory Group, WG4, 20 June 1991
SC21 N 6035	Enhanced Event Management and Log Control, WG4, 1 July 1991 (new work item)
SC21 N 6037	Need for Security Services with OSI Management, SG4, July 1991
SC21 N 6039	Development of Enhanced Functionality for CMIS/P, WG4, 1 July 1991 [CD 1993, DIS 1994, IS 1995], JTC1 N 1438, 3 July 1991 (voting ends 21 October 1991) (new work item)
SC21 N 6040	OSI Software Management - Working Draft, WG4, 20 June 1991
SC21 N 6041	General Relationship Model--Working Draft, WG4, 20 June 1991
SC21 N 6046	Response to Systems Management Tutorial NWI Proposal Ballot (contains initial May 1991 draft of the Systems Management Tutorial), WG4, 20 June 1991
SC21 N 6047	First Working Draft on Management Domains, WG4, 20 June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6048	Working Document on Management Knowledge Management, WG4, 20 June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6049	Working Document on Synchronization, WG4, 20 June 1991 (part of the Extended Systems Management Architecture)
SC21 N 6060	Proposed Draft Answer to Question Q6/1--Versions and Extensibility, SG6, 30 May 1991
SC21 N 6061	Progression of Methodology and Guidelines for the Development of Application Layer Standards, WG6, June 1991
SC21 N 6063	Use of Object Identifiers to Access Directory Information, WG6, 12 June 1991
SC21 N 6068	Modelling Recovery in the Application Layer, WG6, 12 June 1991
SC21 N 6071	Guidelines for Application Context Definition, WG6, 12 June 1991
SC21 N 6079	CD 10746-2, Reference Model of ODP - Part 2: Descriptive Model SC 21/WG 7, 30 May 1991

SC21 N 6080	Working Draft for Part 3 of the Reference Model for ODP, SC 21/WG 7, 30 May 1991
SC21 N 6083	Working Document Partial Text for Part 1 and Part IV of the Reference Model for ODP, SC 21/WG 7, 30 May 1991
SC21 N 6085	Revised NP on ODP Trader, SC 21/WG 7, 30 May 1991
SC21 N 6086	Resolution of Ballot Comments on the NP on ODP Trader, SC 21/WG 7, 30 May 1991
SC21 N 6096	Working Draft of Security Exchange ASE - Part 1: Security Exchange Model and Specification Framework, WG6, 3 June 1991 [Part 2: Security Exchange ASE Service Definition; Part 3: Security Exchange ASE Protocol Specification; and Part 4: Security Exchange ASE PICS Proforma]
SC21 N 6097	Working Draft of Security Exchange ASE - Part 2: Security Exchange ASE Service Definition, WG6, 3 June 1991
SC21 N 6098	Working Draft of Security Exchange ASE - Part 3: Security Exchange ASE Protocol Specification, WG6, 3 June 1991
SC21 N 6099	Authentication Services for Distributed Applications, WG6, 1 July 1991 [WD 5/91, CD 5/92, DIS 5/93, IS 5/94], JTC1 N 1437, 3 July 1991 (new work item)
SC21 N 6110	Session Layer Extension to Support Re-Use of Transport Connections, WG6, JTC1 N 1436, 3 July 1991 (voting ends 21 October 1991) (new work item)
SC21 N 6111	Information Technology - Open Systems Interconnection - Remote Procedure Call, Third Working Draft, WG6, 25 June 1991
SC21 N 6119	RO Extensions--Concepts, Model, and Notation, WG6, 12 June 1991
SC21 N 6120	RO Extensions--Service Definition, WG6, 12 June 1991
SC21 N 6121	RO Extensions--Protocol Specification, WG6, 12 June 1991
SC21 N 6126	LOTOS Description of CCR Service and Protocol, WG6, JTC1 N 1435, 3 July 1991 (voting ends 21 October 1991) [PDTR 5/92, DTR 6/93, TR 6/94] (new work item)
SC21 N 6130	Working Draft for ASN.1 Encoding Rules to Provide Upper Layer Security and Compression, WG6, June 1991
SC21 N 6131	Working Draft on Light-Weight encoding Rules for ASN.1, WG6, 8 July 1991
SC21 N 6133	Abstract Syntax Model, WG6, June 1991
SC21 N 6136	Light Weight Encoding Rules (LWER) for ASN.1, WG6, JTC1 N 1434, 3 July 1991 (voting ends 21 October 1991) (draft is SC21 N 6131) (new work item)
SC21 N 6151	Enhancements to ROSE Service Definition, Protocol Specification, and Concepts, Model and Notation, WG6, 1 July 1991; JTC1 N 1433, 3 July 1991 (new work item)
SC21 N 6158	Final Answer to Q1/62 (Quality of Service Architectural Issues), WG1, May 1991
SC21 N 6159	Framework on Quality of Service, WG1, May 1991 (new project proposal for a TR) (PDTR projected for May 1993, DTR May 1994, TR May 1995)
SC21 N 6160	Catalogue of PICS Proforma Notations, WG1, July 1991
SC21 N 6167	Revised Draft Guide to Open Systems Security, WG1, July 1991
SC21 N 6172	Security Enhancement to Directory (Extension to ISO/IEC 9594-8), WG1, July 1991 (new work item) (CD projected for 4th quarter 1992, DIS second quarter 1993, IS second quarter 1994)
SC21 N 6194	Final Answer to Q1/63.1--Meaning of Conformance to Objects in the Context of OSI Management, WG1, May 1991
SC21 N 6196	PICS Issues (Part 7 to ISO/IEC 9646), WG1, July 1991

SC21 N 6197	WG1 Position on the Reactivation of Project 1.21.9.1 (Multi-Peer Data Transmission), WG1, July 1991 (national body comments requested by 31 March 1992)
SC21 N 6198	Approved Commentaries on the OSI Basic Reference Model [SC21 SD-9], July 1991
SC21 N 6201	Working Draft on Formal Methods in Conformance Testing, WG1, July 1991
SC21 N 6204	List of Late Contributions and Output Documents of SC21/WG1 Arles Meeting, 22-30 May 1991, May 1991
SC21 N 6210	Recommendations Approved by the ISO/IEC JTC1/SC21/WG1 at its Arles Meeting, 22-30 May 1991, May 1991
SC21 N 6217	Recommendations of the ISO/IEC JTC1/SC21/WG5 Meeting, Arles, 23-31 May 1991, June 1991
SC21 N 6224	Proposed EDIFACT/FTAM Document Type, WG5, July 1991
SC21 N 6226 Rev	OSI Distributed Transaction Processing Statement of Results, 14 June 1991
SC21 N 6227	Virtual Terminal Support of ODA, WG5, July 1991
SC21 N 6231	Preliminary Model and Service Definition for Queued Data Transfer, WG5, July 1991
SC21 N 6232	Preliminary TP Security Model, WG5, June 1991
SC21 N 6236	Requirements and Issues for Subtransactions, WG5, June 1991
SC21 N 6239	Working Document for TP Commit Optimization, WG5, June 1991
SC21 N 6240	Requirements and Issues on Separation of Data and Commitment Flows, WG5, June 1991
SC21 N 6243	TP Testing Methodology (Revised), WG5, June 1991
SC21 N 6244	Conformance Test Suite for the TP Protocol - Part 1: Test Suite Structure and Test Purposes, WG5, June 1991
SC21 N 6248	Resolutions of the ISO/IEC JTC1/SC21/WG6 Meeting, 22-31 May 1991, Arles, France, 10 June 1991
SC21 N 6252	Revision of the IRDS Framework, WG3, 1 July 1991 (new work item)
SC21 N 6273	Resolutions of the Seventh Plenary Meeting of ISO/IEC JTC1/SC21, 4-5 June 1991, Arles, France, 20 June 1991
SC21 N 6275	Plan to Mechanize the ISO/IEC JTC1 Secretariat (SC21 Pilot Project), 26 June 1991
SC21 N 7016	Presentation Connection-Oriented Abstract Test Suite (ATS), Specific Partial ATS
SC21 N 7018	Common Partial Embedded ATS (CD text expected June 1992)
SC22 N 190	Specification for a Set of Common Language-Independent Data Types, working draft 4, 6 September 1990
SC22 N 194R	Specification for a Model for Common Language-Independent Procedure Calling Mechanisms, Version 2, 2 December 1990

II. CCITT RECOMMENDATIONS[3]

A. F-SERIES TELEMATIC SERVICES

CCITT F.200♦[4]	Teletex Service
CCITT F.200♦	Teletex Service, Annex C: Mixed Mode of Operation
CCITT F.201♦	Internetworking Between the Teletex Service and the Telex Service
CCITT F.400	Message Handling System and Service Overview
CCITT F.401	Naming and Addressing for Public Message Handling Services
CCITT F.410	The Public Messaging Transfer Service
CCITT F.415	Intercommunication with Public Physical Delivery Services
CCITT F.420	The Public Interpersonal Messaging (IMP) Service
CCITT F.421	Intercommunication Between the IPM Service and the Telex Service
CCITT F.422	Intercommunication Between the IPM Service and the Teletex Service
CCITT F.500	International Public Directory Services

B. I- SERIES ISDN SERVICES

CCITT I.110	General Structure of the I-Series Recommendations
CCITT I.111	Relationship with Other Recommendations Relevant to ISDNs
CCITT I.112	Vocabulary of Terms for ISDNs
CCITT I.113	Vocabulary of Terms for Broadband Aspects of ISDNs
CCITT I.120	Integrated Service Digital Networks (ISDNs)
CCITT I.121	Broadband Aspects of ISDNs
CCITT I.122	Framework for Providing Additional Packet Mode Bearer Services
CCITT I.130	Attributes for the Characterization of Telecommunications Services Supported by an ISDN and Network Capabilities of an ISDN
CCITT I.140	Attribute Techniques for the Characterization of Telecommunication Services Supported by an ISDN and Network Capabilities of an ISDN
CCITT I.141	ISDN Network Charging Capabilities Attributes
CCITT I.144	Number Identification Supplementary Services
CCITT I.200	Guidance to the I.200 Series of Recommendations
CCITT I.210	Principles of Telecommunications Services Supported by an ISDN

3 CCITT Recommendations are final versions of 1988 documents (Blue Book) unless otherwise indicated.

4 The symbol ♦ is used throughout this Section to identify those recommendations included in the November 1989 (Fifth Edition) *NTIS Transition Strategy.*

CCITT I.211	Bearer Services Supported by an ISDN
CCITT I.212	Teleservices Supported by an ISDN
CCITT I.220	Common Dynamic Description of Basic Telecommunication Services
CCITT I.221	Common Specific Characteristics of Services
CCITT I.230	Definition of Bearer Service Categories
CCITT I.231	Circuit-Mode Bearer Service Categories
CCITT I.232	Packet Mode Bearer Service Categories
CCITT I.240	Definition of Teleservices
CCITT I.241	Teleservices Supported by an ISDN
CCITT I.250	Definition of Supplementary Services
CCITT I.251	Number Identification Supplementary Services
CCITT I.252	Call Offering Supplementary Services
CCITT I.253	Call Completion Supplementary Services
CCITT I.254	Multiparty Supplementary Services
CCITT I.255	Community of Interest Supplementary Services
CCITT I.256	Changing Supplementary Services
CCITT I.257	Additional Information Transfer Supplementary Services
CCITT I.310	ISDN - Network Functional Principles
CCITT I.320	ISDN Protocol Reference Model
CCITT I.324	ISDN Network Architecture
CCITT I.325	Reference Configurations for ISDN Connection Types
CCITT I.326	Reference Configurations for Relative Network Resource Requirements
CCITT I.330	ISDN Numbering and Addressing Principles
CCITT I.331	Numbering Plan for the ISDN Era
CCITT I.332	Numbering Principles for Interworking Between ISDNs and Dedicated Networks with Different Numbering Plans
CCITT I.333	Terminal Selection in ISDN
CCITT I.334	Principles Relating ISDN Numbers/Subaddresses to the OSI Reference Model Network Layer Addresses
CCITT I.335	ISDN Routing Principles
CCITT I.340	ISDN Connection Types
CCITT I.350	General Aspects of Quality of Service and Network Performance in Digital Networks, Including ISDNs
CCITT I.351	Recommendations in Other Services Including Network Performance Objectives that Apply at T Reference Point of an ISDN
CCITT I.352	Network Performance Objectives for Connection Processing Delays in an ISDN
CCITT I.410	General Aspects and Principles Relating to Recommendations on ISDN User-Network Interfaces
CCITT I.411	ISDN User-Network Interfaces - Reference Configurations
CCITT I.412	ISDN User-Network Interfaces - Interface Structures and Access Capabilities
CCITT I.420	Basic User-Network Interface (ISDN)
CCITT I.421	Primary Rate User-Network Interface (ISDN)
CCITT I.430♦	Basic User-Network Interface - Layer 1 Specification (ISDN)

CCITT I.431♦	Primary Rate User-Network Interface - Layer 1 Specification (ISDN)
CCITT I.440	ISDN User-Network Interface - Data Link Layer General Aspects
CCITT I.441♦	ISDN User-Network Interface - Data Link Layer Specification
CCITT I.450♦	ISDN User-Network Interface - Layer 3 General Aspects (Q.921)
CCITT I.451♦	ISDN User-Network Interface - Layer 3 Specification (Q.931)
CCITT I.452	ISDN User-Network Interface - Layer 3 Specification - Generic Procedures for the Control of the ISDN Supplementary Services
CCITT I 460♦	Multiplexing, Rate Adaptation and Support of Existing Interfaces (ISDN)
CCITT I.461♦	Support of X.21 and X.21 bis Based DTEs by an ISDN (X.30)
CCITT I.462♦	Support of Packet Mode Terminal Equipment by an ISDN (X.31)
CCITT I.463♦	Support of DTEs with V-Series Type Interfaces by an ISDN
CCITT I.464♦	Multiplexing Rate Adaptation and Support of Existing Interfaces for Restricted 64 kbit/s Transfer Capability
CCITT I.500	General Structure of the ISDN Interworking Recommendations
CCITT I.510	Definitions and General Principles for ISDN Interworking
CCITT I.511	ISDN to ISDN Layer 1 Internetwork Interface
CCITT I.515	Parameter Exchange for ISDN Interworking
CCITT I.520	General Arrangement for Network Interworking Between ISDNs
CCITT I.530	Network Interworking Between an ISDN and a Public Switched Telephone Network (PSTN)
CCITT I.540	General Arrangement for Network Interworking Between Circuit Switched Public Data Networks (CSPDNs) and ISDNs for the Provision of Data Transmission Services
CCITT I.550	General Arrangement for Network Interworking Between Packet Switched Public Data Networks (PSPDNs) and ISDNs for the Provision of Data Transmission Services
CCITT I.560	Requirements to be Met in Providing the Telex Service Within the ISDN
CCITT I.601	General Maintenance Principles of ISDN Subscriber Access and Subscriber Installation
CCITT I.602	Application of Maintenance Principles to ISDN Subscriber Installation
CCITT I.603	Application of Maintenance Principles to ISDN Basic Accesses
CCITT I.604	Application of Maintenance Principles to ISDN Primary Rate Accesses
CCITT I.605	Application of Maintenance Principles to Static Multiplexed ISDN Basic Accesses

C. T-SERIES TELEMATIC SERVICES

CCITT T.0	Classification of Facsimile Apparatus for Document Transmission Over the Public Networks
CCITT T.5♦	General Aspects of Group 4 Facsimile Apparatus
CCITT T.6♦	Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus
CCITT T.50	International Alphabet No. 5
CCITT T.51♦	Coded Character Sets for Telematic Services
CCITT T.60♦	Terminal Equipment for Use in the Teletex Service
CCITT T.61♦	Character Repertoire and Coded Character Sets for the International Teletex Service

CCITT T.62♦	Control Procedures for Teletex and Group 4 Facsimile Services
CCITT T.62 bis	Control Procedures for Teletex and Group 4 Facsimile Services Based on Recommendations X.215/X.225
CCITT T.63♦	Provision for Verification of Teletex Terminal Compliance
CCITT T.70♦	Network-Independent Basic Transport Service for the Telematic Services
CCITT T.71♦	LAPB Extended for Half-Duplex Physical Level Facility
CCITT T.72♦	Terminal Capabilities for Mixed Mode of Operation
CCITT T.73♦	Document Interchange Protocol for the Telematic Services
CCITT T.90♦	Teletex Requirements for Internetworking with the Telex Service
CCITT T.91♦	Teletex Requirements for Real-Time Internetworking with the Telex Service in a Packet-Switching Network Environment
CCITT T.330♦	Telematic Access to Interpersonal Messaging System
CCITT T.400	Introduction to Document Architecture, Transfer and Manipulation
CCITT T.411	Open Document Architecture (ODA) and Interchange Format - Introduction and General Principles (see ISO 8613-1)
CCITT T.412	Open Document Architecture (ODA) and Interchange Format - Document Structures (see ISO 8613-2)
CCITT T.414	Open Document Architecture (ODA) and Interchange Format - Document Profile (see ISO 8613-4)
CCITT T.415	Open Document Architecture (ODA) and Interchange Format - Open Document Interchange Format (ODIF) (see ISO 8613-5)
CCITT T.416	Open Document Architecture (ODA) and Interchange Format - Character Content Architectures (see ISO 8613-6)
CCITT T.417	Open Document Architecture (ODA) and Interchange Format - Raster Graphics Content Architectures (see ISO 8613-7)
CCITT T.418	Open Document Architecture (ODA) and Interchange Format - Geometric Graphics Content Architectures (see ISO 8613-8)
CCITT T.419	Document Transfer and Manipulation (DTAM) - Composite Graphics Content Architectures
CCITT T.431	Document Transfer and Manipulation (DTAM) - Services and Protocols, Introduction and General Principles
CCITT T.432	Document Transfer and Manipulation (DTAM) - Services and Protocols, Service Definition
CCITT T.433	Document Transfer and Manipulation (DTAM) - Services and Protocols, Protocol Specification
CCITT T.441	Document Transfer and Manipulation (DTAM) - Operational Structure
CCITT T.501	Document Application Profile MM for the Interchange of Formatted Mixed Mode Documents (Mixed Mode)
CCITT T.502	Document Application Profile PM1 for the Interchange of Processible Form Documents (Teletex Processible Mode)
CCITT T.503	A Document Application Profile for the Interchange of Group 4 Facsimile Documents
CCITT T.504	Document Application Profile for Videotex Interworking
CCITT T.521	Communication Application Profile BTO for Document Bulk Transfer Based on the Session Service (According to Rules Defined in T.62 bis)
CCITT T.522	Communication Application Profile BT1 for Document Bulk Transfer
CCITT T.523	Communication Application Profile DM-1 for Videotex Interworking

CCITT T.541	Operational Application Profile for Videotex Interworking
CCITT T.561	Terminal Characteristics for Mixed Mode of Operation MM
CCITT T.562	Terminal Characteristics for Teletex Processing Mode PM1
CCITT T.563	Terminal Characteristics for Group 4 Facsimile Apparatus
CCITT T.564	Gateway Characteristics for Videotex Interworking

D. V-SERIES

CCITT V.5	Standardization of Data Signalling Rates for Synchronous Data Transmission in the General Switched Telephone Network
CCITT V.6	Standardization of Data Signalling Rates for Synchronous Data Transmission on Leased Telephone-Type Circuits
CCITT V.10/X.26♦	Electrical Characteristics for Unbalanced Double-Current Interchange Circuits for General Use with Integrated Circuit Equipment in the Field of Data Communication
CCITT V.11/X.27♦	Electrical Characteristics for Balanced Double-Current Interchange Circuits for General Use with Integrated Circuit Equipment in the Field of Data Communications
CCITT V.20♦	Telex and Gentex Signalling on Radio Channels (Synchronous 7-Unit Systems Affording Error Correction by Automatic Repetition)
CCITT V.24♦	List of Definitions for Interchange Circuits Between DTE and DCE
CCITT V.25♦	Automatic Answering Equipment and/or Parallel Automatic Calling Equipment on the General Switched Telephone Network Including Procedures for Disabling of Echo Control Devices for Both Manually and Automatically Established Calls
CCITT V.25 bis♦	Automatic Calling and/or Answering Equipment on the General Switched Telephone Network (GSTN) Using the 100-Series Interchange Circuits
CCITT V.28♦	Electrical Characteristics for Unbalanced Double-Current Interchange Circuits
CCITT V.31♦	Electrical Characteristics for Single-Current Interchange Circuits Controlled by Contact Closure
CCITT V.31 bis♦	Electrical Characteristics for Single-Current Interchange Circuits Using Opto Couplers
CCITT V.35♦	Data Transmission at 48 Kilobits per Second Using 60-108 kHz Group Band Circuits
CCITT V.36♦	Modems for Synchronous Data Transmission Using 60-108 kHz Group Band Circuits
CCITT V.37♦	Synchronous Data Transmission at a Data Signalling Rate Higher than 72 kbit/s Using 60-108 kHz Group Band Circuits
CCITT V.54	Loop Test Devices for Modems

E. X-SERIES PUBLIC DATA NETWORKS

CCITT X.1	International User Classes of Service in Public Data Networks and Integrated Services Digital Networks (ISDNs)
CCITT X.3♦	Packet Assembly/Disassembly Facility (PAD) in a Public Data Network (PDN).
CCITT X.4	General Structure of Signals of International Alphabet No. 5 Code for Data Transmission Over Public Data Networks
CCITT X.10	Categories of Access for DTE to Public Data Transmission Services Provided by PDNs and/or ISDNs through Terminal Adaptors
CCITT X.20♦	Interface Between DTE and DCE for Start-Stop Transmission Services on Public Data Networks

CCITT X.20 bis	Use on Public Data Networks of DTE Which Is Designed for Interfacing to Asynchronous Duplex V-Series Modems
CCITT X.21♦	Interface Between DTE and DCE for Synchronous Operation on Public Data Networks
CCITT X.21 bis♦	Use on Public Data Networks of DTE Which Is Designed for Interfacing to Synchronous V-Series Modems
CCITT X.22♦	Multiplex DTE/DCE Interface for User Classes 3-6
CCITT X.24♦	List of Definitions for Interchange Circuits Between DTE and DCE on Public Data Networks
CCITT X.25-84♦	Interface Between DTE and DCE for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit, 1984
CCITT X.25-88	Interface Between DTE and DCE for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit, 1988
CCITT X.28♦	DTE/DCE Interface for a Start/Stop Mode DTE Accessing the PAD in a PDN Situated in the Same Directory (Country)
CCITT X.29♦	Procedures for the Exchange of Control Information and User Data Between a PAD and a Packet Mode DTE or Another PAD
CCITT X.31♦	Support of Packet Mode Terminal Equipment by an ISDN
CCITT X.32♦	Interface Between DTE and DCE for Terminals Operating in the Packet Mode and Accessing a Packet Switched PDN Through a Public Switched Telephone Network or a Circuit Switched PDN
CCITT X.75-84♦	Terminal and Transit Call Control Procedures and Data Transfer System on International Circuits Between PSDNs
CCITT X.75-88	Terminal and Transit Call Control Procedures and Data Transfer System on International Circuits Between PSDNs
CCITT X.110	International Routing Principles and Routing Plan for Public Data Networks
CCITT X.141	General Principles for the Detection and Correction of Errors in Public Data Networks
CCITT X.150	Principles of Maintenance Testing for Public Data Networks Using DTE and DCE Test Loops
CCITT X.200	Reference Model of OSI for CCITT Applications (see ISO 7498)
CCITT X.208	Specification of Abstract Syntax Notation One (ASN.1) (see ISO 8824, Revised Edition)
CCITT X.209	Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1) (see ISO 8825, Revised Edition)
CCITT X.210	OSI Layer Service Definition Conventions (see ISO TR 8509)
CCITT X.211	Physical Service Definition for OSI for CCITT Applications (see DIS 10022)
CCITT X.212	Data Link Service Definition for OSI for CCITT Applications (see ISO 8886)
CCITT X.213	Network Service Definition for OSI for CCITT Applications (see ISO 8348, 8348/AD 2, and 8348/AD 3)
CCITT X.214	Transport Service Definition for OSI for CCITT Applications (see ISO 8072, 1986)
CCITT X.215	Session Service Definition for OSI for CCITT Applications (see ISO 8826 and 8326/AD 2)
CCITT X.216	Presentation Service Definition for OSI for CCITT Applications (see ISO 8822)
CCITT X.217	Association Control Service Definition for OSI for CCITT Applications (see ISO 8649)
CCITT X.218	Reliable Transfer: Model and Service Definition (see ISO 9066-1)

CCITT X.219	Remote Operations: Model, Notation and Service Definition (see ISO 9072-1)
CCITT X.220	Use of X.200 Series Protocols in CCITT Modifications
CCITT X.223	Use of X.25 to Provide the OSI Connection-Mode Network Service for CCITT Applications (see ISO 8878, 1987)
CCITT X.224	Transport Protocol Specification for OSI for CCITT Applications (see ISO 8073)
CCITT X.225	Session Protocol Specification for OSI for CCITT Application (see ISO 8327 and 8327/AD 2)
CCITT X.226	Presentation Protocol Specification for OSI for CCITT Application (see ISO 8823)
CCITT X.227	Association Control Protocol Specification for OSI for CCITT Applications (see ISO 8650)
CCITT X.228	Reliable Transfer: Protocol Specification (see ISO 9066-2)
CCITT X.229	Remote Operations: Protocol Specification (see ISO 9072-2)
CCITT X.244	Procedure for the Exchange of Protocol Identification During Virtual Call Establishment on Packet Switched Public Data Networks
CCITT X.250	Formal Description Techniques for Data Communications Protocols and Services
CCITT X.290	OSI Conformance Testing Methodology and Framework for Protocol Recommendations for CCITT Applications (see DIS 9646-1 and DIS 9646-2)
CCITT X.300	General Principles and Arrangements for Interworking Between Public Data Networks, and Between PDNs and Other Public Networks
CCITT X.301	Description of the General Arrangement for Call Control Within a Subnetwork and Between Subnetworks for the Provision of Data Transmission
CCITT X.302	Description of the General Arrangement for Internal Network Utilities Within a Subnetwork and Immediate Utilities Between Subnetworks for the Provision of Data Transmission Services
CCITT X.305	Functionalities of Subnetworks Relating to the Support of the OSI Connection-Mode Network Service
CCITT X.310	Procedures and Arrangements for DTE Accessing Circuit Switched Digital Data Services Through Analogue Telephone Networks
CCITT X.320	General Arrangements for Interworking Between ISDNs for the Provision of Data Transmission Services
CCITT X.321	General Arrangements for Interworking Between Circuit Switched Public Data Networks (CSPDNs) and ISDNs for the Provision of Data Transmission Services
CCITT X.322	General Arrangements for Interworking Between Packet Switched Public Data Networks (PSPDNs) and CSPDNs for the Provision of Data Transmission Services
CCITT X.323	General Arrangements for Interworking Between PSPDNs
CCITT X.324	General Arrangements for Interworking Between PSPDNs and Public Mobile Systems for the Provision of Data Transmission Services
CCITT X.325	General Arrangements for Interworking Between PSPDNs and ISDNs for the Provision of Data Transmission Services
CCITT X.326	General Arrangements for Interworking Between PSPDNs and Common Channel Signalling Network (CCSN)
CCITT X.327	General Arrangements for Interworking Between PSPDNs and Private Data Networks for the Provision of Data Transmission Services
CCITT X.353	Routing Principles for Interconnecting the Maritime Satellite Data Transmission System with Public Data Networks
CCITT X.400♦	Message Handling Systems (MHSs): System Model - Service Elements (see ISO 10021-1, MOTIS)

CCITT X.401♦	MHSs - Basic Service Elements and Optional User Facilities
CCITT X.402♦	MHSs - Overall Architecture (ISO 10021-2, MOTIS)
CCITT X.403♦	MHSs - Conformance Testing
CCITT X.407♦	MHSs - Abstract Service Definition Conventions (ISO 10021-3, MOTIS)
CCITT X.408♦	MHSs - Encoded Information-Type Conversion Rules
CCITT X.409♦	MHSs - Presentation Transfer Syntax and Notation [replaced by X.208 (ISO 8824 with DAD 1) and X.208 (ISO 8825 with DAD 1)]
CCITT X.410♦	MHSs - Remote Operations and Reliable Transfer Server [replaced by X.218 (ISO 9066-1), X.219 (ISO 9072-1), X.228 (ISO 9066-2), and X.229 (ISO 9072-2)]
CCITT X.411♦	MHSs - Message Transfer Layer (see ISO 10021-4, MOTIS)
CCITT X.413♦	MHSs - Message Store: Abstract Service Definition (ISO 10021-5, MOTIS)
CCITT X.419♦	MHSs - Protocol Specifications (ISO 10021-6, MOTIS)
CCITT X.420♦	MHSs - Interpersonal Messaging User Agent Layer (ISO 10021-7, MOTIS)
CCITT X.430♦	MHSs - Access Protocol for Teletex Terminals
CCITT X.500	The Directory - Overview of Concepts, Models, and Service (see ISO 9594-1)
CCITT X.501	The Directory - Models (see ISO 9594-2)
CCITT X.509	The Directory - Authentication Framework (see ISO 9594-8)
CCITT X.511	The Directory - Abstract Service Definition (see ISO 9594-3)
CCITT X.518	The Directory - Procedures for Distributed Operation (see ISO 9594-4)
CCITT X.519	The Directory - Protocol Specifications (see ISO 9594-5)
CCITT X.520	The Directory - Selected Attribute Types (see ISO 9594-6)
CCITT X.521	The Directory - Selected Object Classes (see ISO 9594-7)

F. Z-SERIES

CCITT Z.100	Specification and Description Language (SDL)
CCITT Z.110	Criteria for the Use and Applicability of Formal Description Techniques
CCITT Z.200	CCITT High Level Language (CHILL) [see DIS 9496.2]
CCITT Z.301	Introduction to the CCITT Man-Machine Language (MML)
CCITT Z.302	The Meta-Language for Describing MML Syntax and Dialogue Procedures
CCITT Z.311	Introduction to Syntax and Dialogue Procedures (MML)
CCITT Z.312	Basic Format Layout (MML)
CCITT Z.314	The Character Set and Basic Elements (MML)
CCITT Z.315	Input (Command) Langu... yntax Specification (MML)
CCITT Z.316	Output Language Syntax Specification (MML)
CCITT Z.317	Man-Machine Dialogue Procedures (MML)
CCITT Z.321	Introduction to the Extended MML for Visual Display Terminals
CCITT Z.322	Capabilities of Visual Display Terminals (VDTs)
CCITT Z.323	Man-Machine Interaction
CCITT Z.331	Introduction to the Specification of the Man-Machine Interface
CCITT Z.332	Methodology for the Specification of the Man-Machine Interface - General Working Procedures
CCITT Z.333	Methodology for the Specification of the Man-Machine Interface - Tools and Methods
CCITT Z.341	Glossary of Terms (MML)

ORGANIZATIONS FOR STANDARDIZATION[1]

1. INTRODUCTION

This appendix provides an overview of NATO organizations and other bodies with responsibility for standardization in the fields of communications and information systems. Eventually, this appendix is intended to be expanded to show specific responsibilities of each of the standards bodies. Where appropriate, the charts show the class of STANAGs or other standards maintained by each organization. The emphasis in this appendix is on technical standards for data communications.

2. NATO STANDARDS BODIES

Figure F-1 (foldout) identifies the NATO bodies with responsibility for standardization in communications and information systems. The chart only shows the NATO bodies for which staff support is provided by the NATO Headquarter's staffs, with the exception of those associated with the NATO Communications and Information Systems Organization (NACISO). Operational requirements are the responsibility of the Military Committee, primarily through the Military Agency for Standardization (MAS). Procedural standards are the responsibility of the Allied Data Systems Interoperability Agency (ADSIA), which reports to the Military Committee through the NACISO. Technical standards are the responsibility of the Tri-Service Group on Communications and Electronic Equipment (TSGCE).

2.1 NATO Technical Standards Bodies

TSGCE has created a number of subgroups (SGs) and Project Groups (PGs) to develop and maintain technical standards for NATO. The subgroups and selected working groups (WGs) are:[2]

- SG1 on Tactical Area Communications; seeks cooperation among the NATO nations in the development and procurement of tactical area communications for national forces (now part of SG11)
- SG2 on Tactical Communications Equipment; seeks standardization and interoperability of single-channel communications, excluding those covered by SG1 and SG8 (now replaced by SG11)
  - WG2 on Narrowband Speech
  - WG3 on Secure Submarine/Air/Surface Communications
  - WG4 on Tactical Communications Equipment for Use in the Air Environment
  - WG5 on Interoperability Standards for Electronic Counter-Countermeasures (ECCM); seeks ECCM interoperability for tactical single-channel radios in the HF, VHF, and UHF bands
  - WG8 on Short-Range Low-Probability-of-Intercept Communications
- SG4 on Navigation and Position Finding
- SG5 on Identification; seeks to enhance the interoperability of current identification equipment and to ensure the standardization, where necessary, to the NATO Identification System (NIS)

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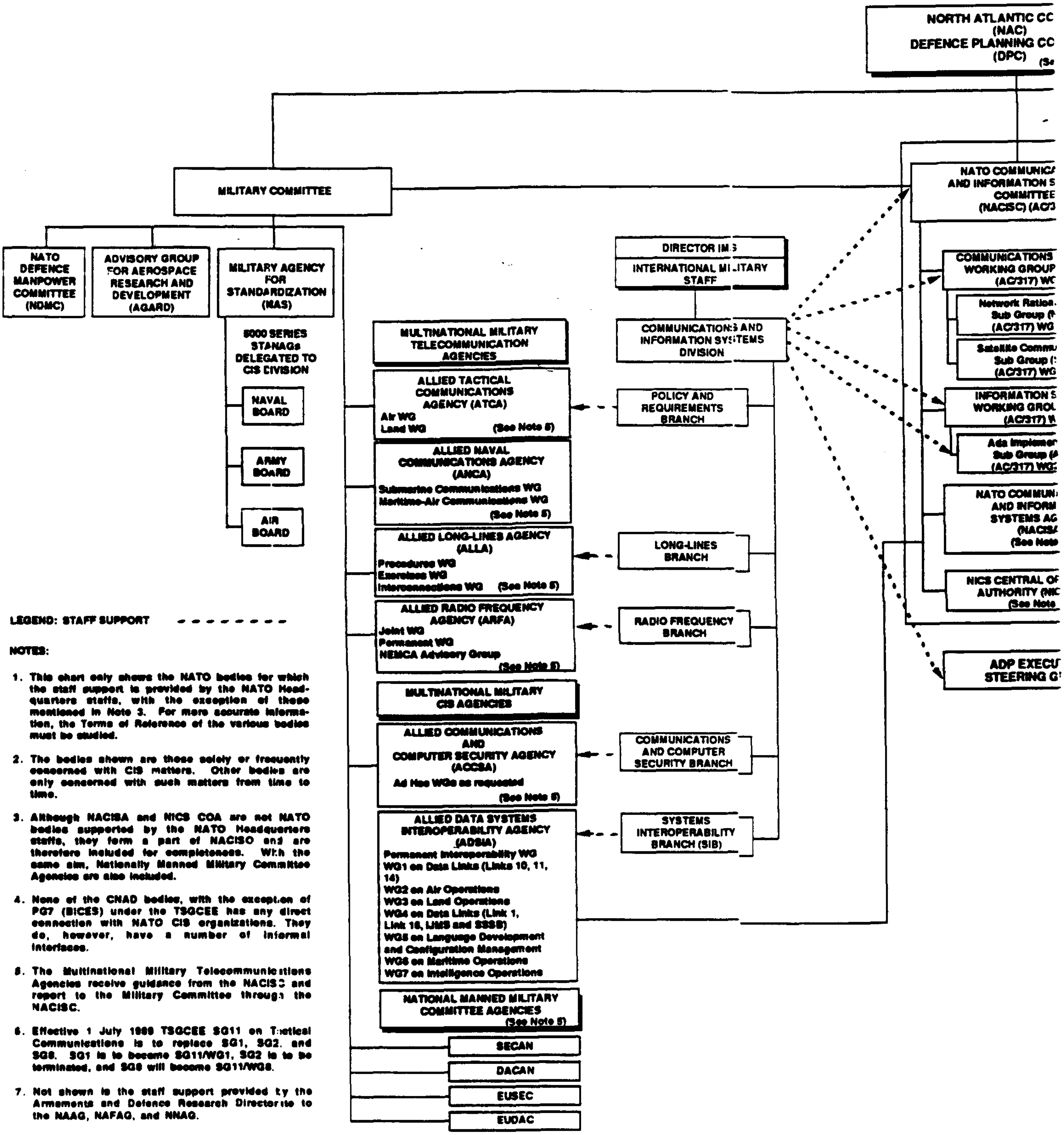
[1] Appendix revised July 1991.

[2] *NATO Bodies in the Fields of Communications and Information Systems*, AC/317-D/23, NACISC, April 1988, NATO UNCLASSIFIED; and USMCEB *Directory--U.S. Participants in the International C3 Fora*, Military Communications Electronics Board, Joint Staff, March 1989, UNCLASSIFIED.



LEGEND: STAFF SUPPORT - - - - - - - -

NOTES:

1. This chart only shows the NATO bodies for which the staff support is provided by the NATO Headquarters staffs, with the exception of those mentioned in Note 3. For more accurate information, the Terms of Reference of the various bodies must be studied.

2. The bodies shown are those solely or frequently concerned with CIS matters. Other bodies are only concerned with such matters from time to time.

3. Although NACISA and NICS COA are not NATO bodies supported by the NATO Headquarters staffs, they form a part of NACISO and are therefore included for completeness. With the same aim, Nationally Manned Military Committee Agencies are also included.

4. None of the CNAD bodies, with the exception of PG7 (BICES) under the TSGCEE has any direct connection with NATO CIS organizations. They do, however, have a number of informal interfaces.

5. The Multinational Military Telecommunications Agencies receive guidance from the NACISC and report to the Military Committee through the NACISC.

6. Effective 1 July 1989 TSGCEE SG11 on Tactical Communications is to replace SG1, SG2, and SG8. SG1 is to become SG11/WG1, SG2 is to be terminated, and SG8 will become SG11/WG8.

7. Not shown is the staff support provided by the Armaments and Defence Research Directorate to the NAAG, NAFAG, and NNAG.

Source: AC/317-D/23, NACISC, April 1988, NATO UNCLASSIFIED.

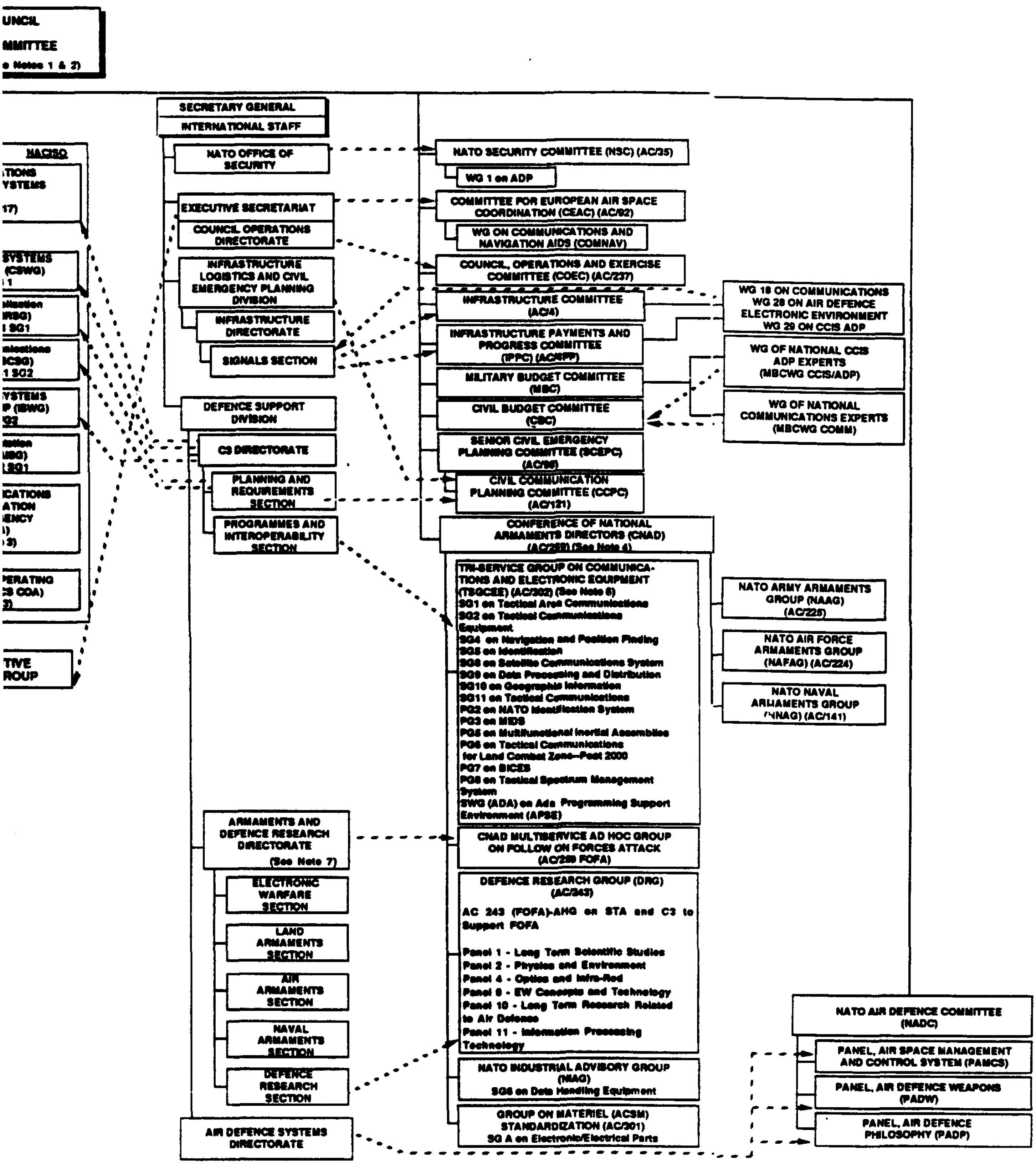


Figure F-1. NATO Bodies in the Fields of Communications and Information Systems

  - WG4 on Question and Answer (Q&A) System Interoperability; dedicated to Mark X/Mark XII issues, but will consider issues affecting the optimum implementation of the NATO Q&A
  - WG5 on Transition to the NIS Q&A
  - WG6 on Data Processing
- SG8 on Satellite Communications (SATCOM) Systems; seeks SATCOM interoperability between NATO and national military SATCOM systems (now part of SG11)
- SG9 on Data Processing and Distribution; focuses on the development of data communications protocols, specifically for the NATO OSI Reference Model
  - WG1 on OSI Layers 1-4--standards and functional profiles
  - WG2 on OSI Layer 5-7--standards and functional profiles
  - WG3 on Communications System/Network Interoperability (CSNI)
  - Ad Hoc Working Group (AHWG) on Security
  - AHWG on Integrated Services Digital Network (ISDN)
  - AHWG on OSI Management
- SG10 on Geographic Information
- SG11 on Tactical Communications (newly formed)
- SG12 on Information Systems (newly formed).

Effective 1 July 1989, TSGCE SG11 replaced SG1, SG2, and SG8. SG1 became WG1 of SG11, SG2 was terminated, and SG8 became WG8 of SG11.

The Project Groups of SG9 are:

- PG2 on NATO Identification System (not currently active; see SG5)
- PG3 on Multinational Information Distribution System (MIDS) (now part of SG9)
  - WG1 on the MIDS STANAG 4175
  - WG2 on the MIDS Terminal Development
- PG5 on Multifunctional Inertial Sensor Assemblies
- PG6 on Tactical Communications Systems for the Land Combat Zone--Post 2000; seeks, through a coordinated program, tactical communications systems designed to common standards (now part of SG11)
- PG7 on Battlefield Information and Exploitation Systems (BICES); WG1 is working on a NATO ESM System (now part of SG12)
- PG8 on a Tactical Spectrum Management System, planned to support management of radio frequencies in the combat zone.

Liaison among these bodies (e.g., PG6 and SG9) is normally at the Secretary level. Plans are coordinated in annual meetings of the Secretaries and Action Officers of the Allied Tactical Communications Agency (ATCA), the Allied Naval Communications Agency (ANCA), the Allied Communications and Computer Security Agency (ACCSA), and the communications subordinate groups of TSGCE.[3]

To a limited degree, technical standards are also being addressed in the NATO Industrial Advisory Group (NIAG), specifically in SG6 on Compatibility of Naval Data Handling Equipment. NIAG SG6 is making recommendations on standards to be used in shipboard combat systems for data distribution, such as the Network Independent Interface (NIIF).

Table F-1 and Figure F-2 highlight the relationships among the NATO standards bodies whose responsibilities be discussed in a chart that follows. To clarify the relationships among the organizations and to emphasize those bodies concerned with technical standards, some of the NATO bodies

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3 "Working Relationships," Note by the Secretary, AC/317-N/185, NACISC, 24 February 1989, NATO UNCLASSIFIED.

Table F-1. Acronyms and Titles of Key NATO Bodies in the Fields of Communications and Information Systems

Acronym	Name
NAC	North Atlantic Council
DPC	Defence Planning Committee
MC	Military Committee
AGARD	Advisory Group for Aerospace Research and Development
MAS	Military Agency for Standardization
MNCs	Major NATO Commands
ACE	Allied Command Europe
CHAN	Allied Channel Command
LANT	Allied Command Atlantic
ATCA	Allied Tactical Communications Agency
ANCA	Allied Naval Communications Agency
ALLA	Allied Long Lines Agency
ARFA	Allied Radio Frequency Agency
ACCSA	Allied Communications and Computer Security Agency
ADSIA	Allied Data Systems Interoperability Agency
SECAN	Communications Security and Evaluation Agency
DACAN	Distribution and Accounting Agency
EUSEC	European Security and Evaluation Committee
	European Distribution and Accounting Agency
IMS	International Military Staff
CIS DIV	Communications and Information Systems Division
NACISO	NATO Communications and Information Systems Organization
NACISC	NATO Communications and Information Systems Committee
CSWG	Communications Systems Working Group
NRSG	NATO Rationalization Subgroup
SCSG	Satellite Communications Subgroup
ISWG	Information Systems Working Group
AISG	Ada Implementation Subgroup
NACISA	NATO Communications and Information Systems Agency
NICS-COA	Central Operating Authority
CNAD	Conference of NATO Armaments Directors
TSGCE	Tri-Service Group on Communications and Electronics
NAAG	NATO Army Armaments Group
NAFAG	NATO Air Force Armaments Group
NNAG	NATO Navy Armaments Group
DRG	Defence Research Group
NIAG	NATO Industrial Advisory Group
CEAC	Committee for European Airspace Coordination
NADC	NATO Air Defence Committee

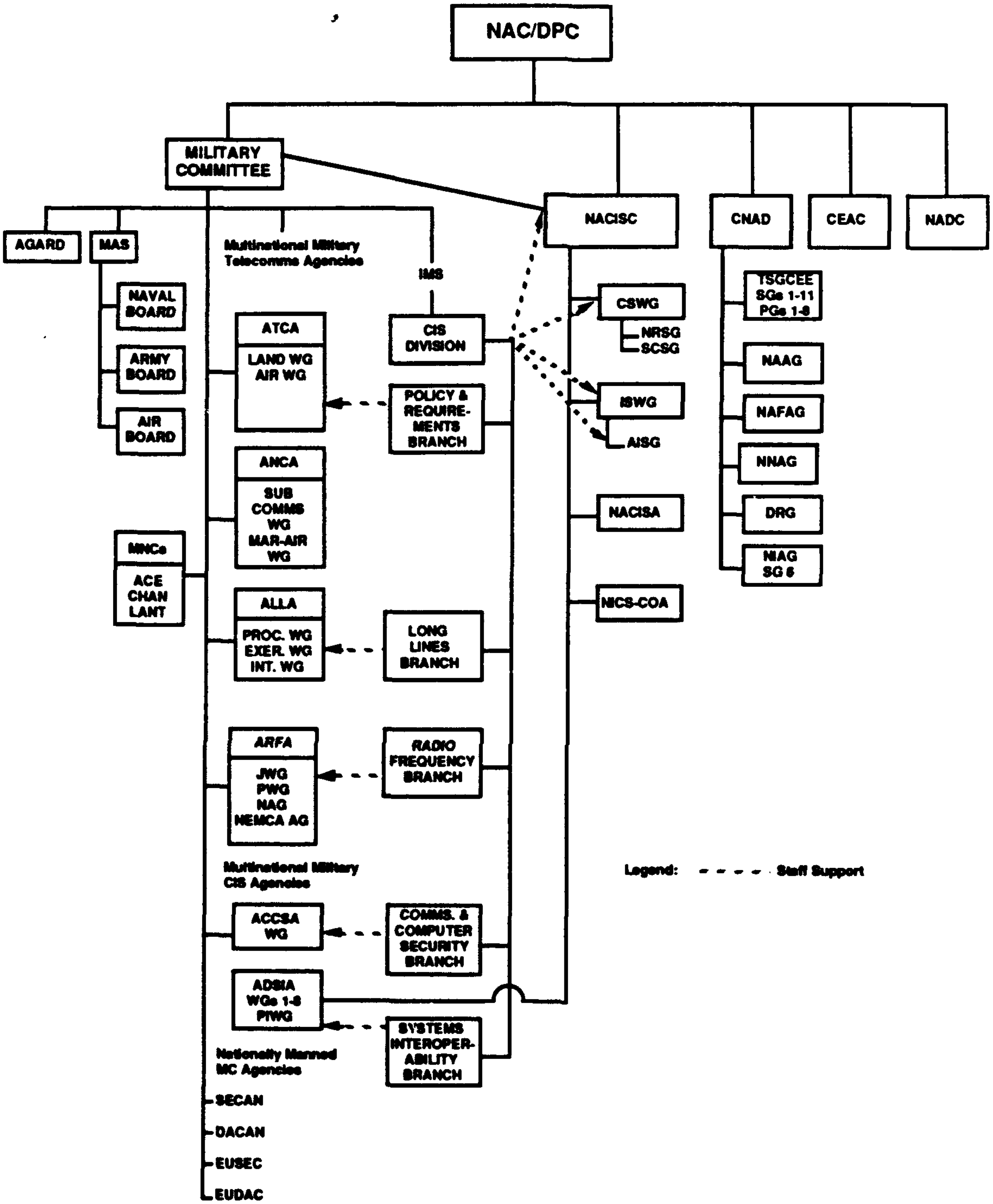

Figure F-2. NATO Standards Bodies for Communications and Information Systems

have been left out and most of the names have been replaced with acronyms. Table F-1 provides the definitions of the acronyms for Figure F-2.

2.2 NATO OSI Standards Bodies

TSGCE SG9 has responsibility for the NATO OSI Reference Model and developing OSI STANAGs. SG9 also maintains the *NTIS Transition Strategy* [Purton 1987] that contains intercept recommendations.

TSGCE SG9 meets biannually, usually in March and October. Beginning in 1990, SG9 will meet approximately 6 to 8 weeks after the fall meetings of WG1 and WG2, to allow time for the nations to coordinate positions on issues developed by the working groups. Thus, the next meeting of SG9 is December 1990, while WG1 and WG2 will meet in October 1990. AHWGs meet approximately quarterly.

2.3 Standards Responsibilities of Selected NATO Bodies

Table F-2 is an incomplete first draft of an effort to identify the specific responsibilities of NATO organizations for technical standards. Eventually, this and similar tables for other groups of standards bodies will be analysed to identify overlaps as well as possible gaps in the standards coverage.

Table F-2. Responsibility for Standards in NATO Bodies

NATO Organization	Title	Standards Responsibility
CNAD	Conf of Nat'l Armaments Directors	
TSGCEE	Tri-Serv Group Comm-Electron Equipment	Technical Standards
SG1	Tactical Area Communications	STANAGs 4206-4214,4249,4290,4295,5000-5018
SG2	Tactical Radio Equipment	STANAGs 4197-4205,4245-46,4285-92,4335-39,5020
SG3	Multi-Functional Info Distribution	
SG4	Navigation and Position Finding	
SG5	Identification	
SG7	Channel Eval Tech in HF Communications	
SG8	Tactical SATCOM Terminal	STANAGs 4231-33, 4271
SG9	Data Processing and Distribution	NATO OSI Standards; STANAG 4250
AHWG-Security	OSI Security	NATO OSI Standards (Annex B)
AHWG-OM	OSI Network Management	NATO OSI Standards (e.g., Net Mgmt)
AHWG-ISDN	Integrated Services Digital Network	ISDN Standards for Open Systems
WG1	Lower 4 Layers of Reference Model	STANAGs 4251-54, 4261-64
WG2	Upper 3 Layers of Reference Model	STANAGs 4255-56, 4258-59, 4265-66
AHWG-MMHS	Military Msg Handling System	STANAG 4257
WG3	Comm System/Network Interoperability	MOU for Multinational Programme
SG10	Geographic Information	
PG2	NATO Identification System	
PG3	MIDS	
PG4	Low Cost INS for Ships	
PG5	Multi-Functional Inertial Sensor Assembly	
PG6	Tac Comm Post 2000-Land Combat	
PG7	BICES	
PG8	Tactical Spectrum Mgmt System	
OGN	Conformance Testing	
NIAG	NATO Industrial Advisory Group	
SG6	Naval Data Handling Equipment	Functional Profiles
NACISC	NATO Comm and Info Sys Committee	Oversight for Procedural Standards
CSWG	Comm Systems Working Group	
ISWG	Information Systems Working Group	
AISG	Ada Implementation Subgroup	
NACISA	NATO Comm and Info Sys Agency	
NICS-COA	Central Operating Authority	
MC	Military Committee	
IMS	International Military Staff	
CCCS Div	Command, Control and Comm System	STANAGs 5000-6999
CISD	Comm and Info Systems Divison	
SIB	Systems Interoperability Branch	
MAS	Military Agency for Standardization	Operational Standards (STANAGs 1000-3999)
Air Board	Air Board	STANAGs 8000-8999
ACCSA	Allied Comm and Comp Sec Agency	
PSN WG	Packet Switched Network	
ADSIA	Allied Data Systems Interop Agency	Procedural Standards
PIWG	Permanent Interoperability WG	
WG1	Maritime TDS Interoperability Standards	Data Links 10, 11, and 14
WG2	Air Operations	
WG3	Land Forces TDSs	
WG4	Inter-Service Data Systems	Data Links 1,16; IJMS,SSSB; STANAG 5516
WG5	Character-Oriented	Language Development and Configuration Mgmt
WG6	Maritime Operations	
WG7	Intelligence Operations	Intelligence Messages
WG8	Common Operational Vocabulary	
SECAN	Comm Security and Eval Agency	

3. INTERNATIONAL STANDARDS BODIES

Table F-3 identifies standards bodies from CCITT, ISO, and ECMA that recommend, develop, and maintain technical standards for communications and information processing. The primary international bodies are described below.[4] National standards bodies are identified in Chapter 4 of this appendix.

3.1 ISO/IEC

The International Organization for Standardization (ISO) has 89 members representing national standards bodies (e.g., AFNOR in France, JISC in Japan, ANSI in the United States, BSI in the United Kingdom). The International Electrotechnical Commission (IEC)[5] is a federation of more than 200 national committees working in the area of electronics and electrical standards with specific interest in information processing. ISO and IEC have formed a joint committee, Joint Technical Committee One (JTC1), to develop standards for information processing systems.

3.2 CCITT/CCIR

The Comite Consultatif International pour le Telephone et le Telegraph (CCITT) is the permanent organ of the Union Internationale des Telecommunications (UIT), which groups all the Postal Telephone Telegraph (PTT) administrations of the world's countries. CCITT develops standards in 4-year cycles and works closely with ISO to harmonize results. The Comite Consultatif International pour les Radiocommunications (CCIR) and the International Frequency Registration Board (IFRB) are the other two standards organs of the UIT; together with the CCITT, they are all based in Geneva.

3.3 CEN/CENELEC

The Comite Europeen de Normalisation (CEN) is a grouping of the national organizations of 16 countries of the European Community (EC) and the European Free Trading Association (EFTA).[6] CEN works in cooperation with the Comite Europeen de Normalisation Electrotechnique (CENELEC) to develop and publish European standards [normes europeennes (ENs)]. CENELEC deals exclusively with electrotechnical standards and CEN works with standards in all other areas. Based in Brussels, CEN/CENELEC works to harmonize standards that are established by its members and to create European standards where no other appropriate standards exist. CEN/CENELEC members include AFNOR (France), UNI (Italy), DIN (Germany), BSI (United Kingdom), IBN (Belgium), DCQ (Portugal), and SIS (Sweden).

CEN/CENELEC standards are initially distributed for comment by member bodies in the form of an experimental standard (ENV[7]) or a European prestandard (prENV). Future technical work in developing proposals for ENVs has now been taken over by the European Workshop for Open Systems

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4 "La Galaxie de la Normalisation," Telecoms Magazine, 1989; *The OMNICON Index of Standards for Distributed Information and Telecommunication Systems*, OMNICON, 1987; and "The Value and Use of IT Standards in Public Procurement," PPSC-IT N268.1, Commission of the European Communities, August 1988, UNCLASSIFIED.

5 The IEC is also known as the Commission Electrotechnique Internationale (CEI).

6 The EFTA is also known as the Association Europeenne de Libre Exchange (AELE).

7 The "V" in ENV is for "Vornorm," and indicates a standard based on DIS or other draft standards that are not completely stable; modifications to ENV standards may eventually be required to bring them in line with international standards. ENVs are valid for 3 years--they are reviewed after 2 years and may then become an EN, be prolonged for another 2 years, be replaced by another ENV, or be withdrawn.

Table F-3. Responsibilities for Communications and Information Processing in International Civil Standards Bodies

International Organization	Title	Standards Responsibility
CCITT	International Consult Comm Telephone Telegrams	
SG I	Definitions, Operation & Quality of Service	
SG II	Operation of Telecommunication Network & ISDN	
SG III	General Tariff Principles	
SG IV	Transmission Maintenance	
SG VII	Data Communication Networks	OSI standards; facilities, I/Fs
WG1	Network Services, Facilities, Prototypes	
WG2	Network Access Interfaces	
WG3	Internetworking, Switching, Signal	
WG4	Transmission & Message Handling	
WG5	Routing, Numbering, Layered Model	
SR ISDN	ISDN-Related Issues	
SR DEFs	Terms and Definitions	
SG VIII	Telematic Services	OSI standards; FAX, teletex, videotex
WG1	Terminal Characteristics	
WG2	Common Protocols & Internetworking	
SG IX	Telegraph Networks & Terminal Equipment	
SG X	Languages & Methodology for Telcomm Applications	
SG XI	ISDN & Telephone Network Switching	
SG XII	Transmission Performance of Telephone Network	
SG XV	Transmission Systems	
SG XVII	Data Transmission over Telephone Network	
SG XVIII	Digital Networks including ISDN	OSI standards for ISDN
CCIR	International Radio Consultant Committee	
CEN	European Communications for Standardization	
CENELEC	European Communications for Telecom Standardization	
CEPT	European Conf of Postal & Telecom Administration	
CCH	Harmonization Coordination Committee	
CAC	Commercial Action Committee	
CLTA	Liaison Committee for Transatlantic Telecommunications	
ECMA	European Computer Manufacturing Association	
TC29	Text Preparation & Interchange	Telematic services; text/office systems
TC32	Communications, Networks & Systems Interconnection	OSI standards
TG1	Public Data Networks	
TG3	Local Area Networks	
TG6	Interfaces to Private Switching Networks	
TG7	Transport & Network Layers	Layer 3 and Layer 4 OSI standards
COS	Corporation for Open Systems	
COSINE	Corporation for Open Systems in Europe	
EMUG	European MAP User Group	
ETSI	European Telecommunication Standards Institute	
EWOS	European Workshop on Open Systems	

Table F-3. (Continued)

International Organization	Title	Standards Responsibility
ISO	International Organization for Standardization	
JTC1 (TC97)	Technology Committee on Information Processing Systems	Promote standards worldwide
TSG-1	Tech Study Group on IAP	Interfaces for Application Portability
SC1	Vocabulary	
SC2	Character Sets & Information Coding	
SC6	Telecommunications and Info Exchange Between Systems	OSI standards
WG1	Data Link Layer	Layer 2 OSI standards
WG2	Network Layer	Layer 3 OSI standards
WG3	Physical Layer	Layer 1 OSI standards
WG4	Transport Layer	Layer 4 OSI standards
WG5	Architecture, Layers 1-4	OSI Architecture
SC7	Software Development & Systems Documentation	
WG2	Documentation	
WG3	Software Quality Characteristics	
SC11	Flexible Magnetic Media	
SC13	Interconnection of Equipment	
SC14	Representation of Data Elements	
SC15	Labelling and File Structure	
SC17	Identification and Credit Cards	
SC18	Text and Office Systems	Message handling protocols
WG4	Text Interchange	MOTIS
WG9	User System Interfaces & Symbols	
SC20	Data Cyrptographic Techniques	
SC21	Information Retrieval, Transfer, & Management	OSI and other standards
WG1	OSI Architecture	OSI architecture, concep schema
WG3	Database (not part of OSI)	
WG4	OSI Management	
WG5	Specific Application Services	Layer 7 (TM, FTAM, JTM, VT)
WG6	Session & Presentation Layers; ASCEs	Layer 5 and layer 6 OSI standards
WG7	Open Distribution Procedures (not part of OSI)	
SC22	Languages	
WG15	POSIX	
SC23	Optical Digital Data Disks	
SC24	Computer Graphics	(Work formerly done by SC21/WG2)
SC47B	Microprocessor Systems	
SC83	Information Technology Equipment	
IEC	International Electrotechnical Commission	
IFIP	International Federation for Information Processing	
ITSTC	Information Technology Steering Technology Committee	
OSITOP	OSI for Technical & Office Protocol	
OSF	Open Software Foundation	
POSI	Promotion Conference for OSI	Asia-Oceania workshop/standards forum
SOGITS	Senior Official Group for Info Tech Standardization	Commission of European Communities
SOGT	Senior Official Group on Telecommunications	Commission of European Communities
SPAG	Standards Application & Promotion Groups	
UER	European Union on Radiobroadcasting	
X/OPEN	X/OPEN	

(EWOS). When proposed international standards are harmonized with national standards, harmonized documents (HDs) are produced. When adopted, an HD must be used and national deviations can only exist temporarily. European norms (ENs) must be adopted as national standards, and any conflicting national standards must be withdrawn. An example standard is ENV 41201, Private Message Handling System. A second class of standards promulgated by CEN/CENELEC are the Telecommunications European Norms (NETs), which are common technical specifications covering access to networks and equipment. Examples are NET2 (X.25 Access) and NET3 (ISDN Basic Access).

CEN/CENELEC standards originate as draft documents, standards proposals, and implementors guides developed by various standards promoting organizations. When stable, these documents are reviewed and coordinated by the European Telecommunications Standards Institute (ETSI) and EWOS and are issued for comment as functional specifications, recommendations, and technical specifications. When the review is complete, they are forwarded to CEN/CENELEC, or to the Conference Europeenne des Postes et Telecommunications (CEPT), for final standards development.[8]

3.4 ECMA

The European Computer Manufacturer Association (ECMA) represents a group of about 30 manufacturers in Europe. ECMA, based in Geneva, acts as observer at ISO and as a consultant at CCITT. ECMA takes an active role in the definition of functional profiles with EWOS.

3.5 SPAG

The Standards Application and Promotion Group (SPAG), based in Brussels, was created by 12 major European manufacturers (e.g., Bull, ICL, Siemens). SPAG seeks to accelerate standardization by selecting, among all OSI standards, a limited number for implementation. The stacks of standards are called profiles and are developed toward supporting complete applications, such as FTAM. SPAG has made a major contribution to the rapid progress of European experimental standards (ENVs) and standards (ENs).

3.6 OSITOP

Open Systems Interconnection for Technical and Office Protocol (OSITOP) is an association of users (such as BNP, EDF/GDF) for the promotion of ISO functional profiles and the concept of TOP.

3.7 EMUG

The European Manufacturing Automation Program (MAP) User Group (EMUG) was created in 1985 by a large group of manufacturers. It aims to promote the MAP standards in Europe. Specific groups in the nations, such as the Club Informatique des Grandes Enterprises Francaises (CIGREF) in France, are appointed to be EMUG's representatives. A key element of MAP, the Manufacturing Message Specification (MMS) has reached DIS status (DIS 9506).

3.8 EWOS

The European Workshop on Open Systems (EWOS) promulgates harmonized technical proposals for functional profiles of OSI standards and corresponding conformance test specifications. EWOS has been given the responsibility for technical work in developing proposals for ENVs, with increased involvement of users. When complete, the proposals are submitted to CEN/CENELEC. The founding members of EWOS include CEN, CENELEC, ECMA, EMUG, OSITOP, Reseaux Associes pour le Recherche Europeenne (RARE, Association of European Research Networks), and the Corporation for Open Systems Interconnection Networking in Europe (COSINE). The member bodies of EWOS have agreed not to undertake on their own any new work on the development of functional standards.

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8 Briefing on EUROPE 92--The European Community's Approach to Integration in the Information Technology Area, Fred Griefenstein, Softsiel Corporation, San Diego, 15 May 1989.

3.9 Support to the Commission of the European Community (CEC)

The Senior Official Group for Information Technology Standardization (SOGITS) and the Senior Official Group on Telecommunications (SOGT) assist the CEC in the implementing legislation for information technology standards. The Public Procurement Subcommittee in the Information Technology Sector (PPSC-IT) enforces the role of standards in public procurement for the CEC.

3.10 ITSTC

The Information Technology Steering Technical Committee (ITSTC) provides recommendations for European members in three areas: standards (the Information Technology Ad-hoc Expert Group for Standards), manufacturing/automation (the Information Technology Ad-hoc Expert Group for Manufacturing), and certification (the Information Technology Ad-hoc Expert Group for Certification). While the ITSTC does not produce standards, it does define programmes for European standards and organizes and coordinates the work.

3.11 CEPT/ETSI/UER

Three consortia represent the interests of public telecommunication administrations of European countries, including France, the United Kingdom, and Germany. The Conference Europeenne des Postes et Telecommunications (CEPT) coordinates political aspects and prepares technical specifications for member administrations (but does not produce any standards). The CEPT has 20 member countries and works closely with CEN/CENELEC. The European Telecommunications Standards Institute (ETSI) is an organization created within CEPT to prepare specifications concerning public telecommunications networks. The Union Europeenne de Radiodiffusion (UER) is a technical committee with the aim of harmonizing radio broadcasting system standards; its proposals are transmitted to the CCIR and the IEC. The UER has 32 countries actively participating and 45 associated member bodies.

3.12 COS/COSINE

The Corporation for Open Systems (COS) and the Corporation for Open Systems Interconnection Networking in Europe (COSINE) participate in the development of functional profiles for OSI and plays an active role in setting standards for testing OSI products for conformance to the international standards and profiles. COS is based in Vienna, Virginia, in the United States, and COSINE is based in Paris. COS has over 60 member organizations, both vendors and users.

COSINE is a project established by the CEC to promote internetworking facilities between industrial and academic research and development communities throughout Europe. Participating countries are Austria, Belgium, Denmark, Finland, France, West Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and Yugoslavia. COSINE has been working closely with RARE in specifying standards initially to be used in a pan-European networking infrastructure.

3.13 X/OPEN

X/OPEN is a non-profit consortium developing extensions to UNIX SVID operating system standards to support a distributed transaction processing environment that meets OSI standards. X/OPEN is developing a Common Applications Environment to promote software portability. Alignment of both activities with the emerging POSIX standards is planned.

3.14 OSF

Created in 1988, the Open Software Foundation (OSF) is a group of over 90 information systems companies (including International Business Machines) for the promotion of standards, such as the POSIX standard for operating system interfaces.

3.15 IFIP

The International Federation for Information Processing (IFIP) is a group of international experts drawn principally from universities and also from some industries (e.g., Xerox, Bell). IFIP has contributed to the work of ISO on the OSI model and, more recently, to the work on X.400-type message handling systems.

3.16 POSI

Created by six major vendors in Japan and the Nippon Telephone and Telegraph (NTT), the Promotion Conference for Open Systems Interconnection (POSI) is the equivalent to SPAG in Europe and to COS in the United States. POSI is an Asia-Oceania regional forum for the international workshops on OSI, and as such, seeks agreements among vendors to ensure interoperability and compatibility of products. The POSI regional workshop is known as the Asia-Oceania Workshop (AOW).

3.17 ODAC

Six major international computer companies formed the Open Document Architecture Consortium (ODAC) in early 1991 to develop a toolkit of software that conforms to the ISO ODA standard. The toolkit will be openly licensed to allow other computer companies and systems developers to build software applications using ODAC's published specifications. It is expected to be available in 1993. The consortium members are currently: Digital, ICL, Siemens Nixdorf Informationsysteme, Groupe Bull, IBM, and Unisys. The Consortium has been established as a European Economic Interest Group in Brussels. [OSN 1991b, 24]

3.18 OSINET

OSINET was formed in 1984 under the auspices of NIST. Governed by its membership it works in three specific areas: (1) the research and development of test scripts which are used in OSI interoperability testing, (2) the interoperability testing and registration of announced OSI products, and (3) the demonstration and promotion of ISO technology. The U.S.-based organization comprises 55 members and recently voted to reorganize under the auspices of COS [OSN 1991b, 23].

4. NATIONAL STANDARDS BODIES

This section identifies national standards bodies and their responsibilities for standards development or use.[9] Additional contributions to this section would be welcomed.

4.1 Belgium

The Institut Belge de Normalisation (IBN) is the primary standards body for Belgium.

4.2 Canada

The Canadian Standards Association (CSA) is responsible for the development of OSI standards in Canada. The Standards Council of Canada (SCC) is a Canadian national non-governmental agency that develops standards policy. The SCC provides coordination and support for the National Standards System (NSS) and supports Canada's participation in international standards work.

4.3 Denmark

Danish Standards Association (Dansk Standardiseringsrad) is the ISO member body from Denmark. It is also the member body for CEN.

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9 *The OMNICON Index of Standards for Distributed Information and Telecommunication Systems*, OMNICON, 1987, UNCLASSIFIED.

4.4 France

The Association Francaise de Normalisation (AFNOR) is the French official organization for normalization/standardization and the French member body for ISO. It works with manufacturers, users, and administration. It promulgates international standards in France, chooses working groups in which France is to take an active part, manages French technical experts, and defines/coordinates the proposals they must put forward in discussions. The AFNOR role also includes giving information--it sends out literature on national and international standards and answers questions from manufacturers and users. AFNOR standards are classified according to the activity to which they relate. For example, Class Z corresponds to data processing. The Union Technique de l'Electricite (UTE) is the member of CENELEC from France and an active participant in AFNOR for the development and exploitation of standards for electricity and electronics.

4.5 Germany

The Deutsches Institut fur Normung (DIN) is the official organization for standardization for the Federal Republic of Germany and Berlin (West) and is the member body of ISO and CEN.

4.6 Netherlands

The Nederlands Normalisatie-Instituut (NNI) is the ISO member body for the Netherlands. When ISO or CCITT standards are translated or modified, they are issued by NNI as NENs. For example, NEN-ISO 3309 is a translation of an ISO HDLC standard.

4.7 United Kingdom

The British Standards Institute (BSI) is the UK member of ISO and the recognized body for the preparation and promulgation of British national standards.

4.8 United States

The American National Standards Institute (ANSI) is the U.S. member of ISO and a U.S. clearinghouse for voluntary standards.

Table F-4 identifies ANSI and other standards bodies[10] in the United States, both civil and military, that recommend, develop, manage, and maintain technical standards for communications and information processing.

Table F-5 identifies all the current Technical Committees (TCs) currently active in ANSI for Infomation Processing Systems (X3).

4.9 Standards Bodies in Non-NATO Nations

Finland is represented in ISO and IEC by the Suomen Standardisoimisliitto (SFS).

Sweden is represented in ISO by the Standardiseringskommisionen i Sverige (SIS). SIS coordinates with the Swedish Electrical Commission (SEK) and the Swedish Mechanical Standardization (SMS).

The Irish member of ISO and CEN is the National Standards Authority of Ireland (NSAI), an autonomous unit of the Institute for Industrial Research and Standards (IIRS).

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10 Similar tables need to be developed for standards bodies in other nations. Additional contributions will be included in future editions of this working paper.

The Japanese Industrial Standards Committee (JISC) oversees the Japanese Industrial Standards (JISs). The JISC is attached to the Agency of Industrial Science and Technology, Ministry of International Trade and Industry (MITI). JISC members include representatives from manufacturers, consumers, and knowledgeable individuals. Texts of standards approved by the relevant Minister and announced in the Government Gazette are published by the Japanese Standards Association (JSA). An Information Technology Standardization Technology Committee (INSTAC) within the Japanese Standards Association, the Telecommunications Technology Committee (TTC), the Interoperability Database System Development Project, and the Interoperability Association for Information Processing (INTAP) were established in 1985 to promote interoperability technology. INTAP has the responsibility to develop functional standards and conformance tests for OSI in Japan.

The Saudi Arabian Standards Organization (SASO) represents Saudi Arabia in ISO and IEC.

Table F-4. Responsibilities for Communications and Information Processing in U.S. Standards Bodies [11]

U.S. Organization	Title	Standards Responsibility
ANSI X3	Information Processing	
X3S3	Technology Committee (TC) on Data Communications	Devel of US OSI standards; input to ISO JTC1/SC21
X3S3.1	Task Group on Data Communications Planning	General standardization efforts
X3S3.2	Task Group on Communications Vocabulary	Data transmission vocabulary
X3S3.3	Task Group on Network Layer	Directory, management, routing, ISDN
X3S3.4	Task Group on Control Procedures	Protocols, procedures, & management; X.25
X3S3.5	Task Group on Communications Systems Performance	Nomenclature, presentation & performance measurement
X3S3.7	Task Group on Public Data Network Access	ISDNs, gateways (X3.100, X.25, X.75, X.32)
X3T2	Technology Committee on Data Interchange	
X3T3	Technology Committee on ODP	
X3T4	Technology Committee on Security Techniques	
X3T5	Technology Committee on OSI	Development of US OSI standards; input to ISO JTC1/SC21
X3T5.1	OSI Architecture; Reference Model	FDTs; Conf Testing; Sec, Open Distributed Proc
X3T5.4	Task Group on OSI Management Protocols	Management, MIS, directory service
X3T5.5	Presentation and Application Layers	CL mode, VT, ANS.1
X3T5.7	Task Group on OSI Security Techniques	
X3T6	Task Group on Non-Contact Information Systems Interface	
X3T9	Technology Committee on I/O Interface	
X3T9.2	Task Group on Lower Level Interface	
X3T9.3	Task Group on Device Level Interface	
X3T9.5	Task Group on Local Distribution Data Interface	
X3V1	Office and Publishing Systems	
X3V1.1	Task Group on User Requirements M.S.T.	
X3V1.3	Task Group on Document Architecture	
X3V1.4	Task Group on Text Interchange	
X3V1.5	Task Group on Content Architecture	
X3V1.8	Task Group on Text Description and Process Language	
X3V1.9	Task Group on User Systems Interface/Symbols	
X3V1.10	Task Group on Font Resources	
USCCITT	US Organization for CCITT	
NC	National Committee	
GS-A	Telecommunication policies & services	
SG-B	WATTC-1988	
SG-C	Worldwide telephone network	
SG-D	Data and ISDN	
JWP	Joint Working Party on ISDN	
IEEE	Institute for Electrical and Electronic Engineering	
802	Committee on Local Area Networks	
Ad-hoc	Study Group on Functional Requirements	
802.1	Overall architecture of LANs/internetwork	
802.1A	Glossary	
802.1B	Network Management	
802.1D	Mac Sublayer Interconnection	
802.1E	System Load Protocol	
802.1F	Recommended Practices for Development of IEEE 802	
802.1G	Mac Sublayer Interconnection	
802.1I	Standard Mac Bridges - FDDI Supplement	
802.2	Logical link control	
802.3	CSMA/CD	
802.4	Token-passing bus access methodology	
802.5	Token ring access methodology	
802.6	Metropolitan area networks	
802.7	Broadband tech adv group	
802.8	Fiber-optics tech adv group	
802.9	Integrated Voice and Data (IVD) LAN Interface Standard	
802.10	Secure local area networks	
P1003	POSIX	
P1201	Window Interface	

11 Updated from Accredited Standards Committee X3, Information Processing Systems, *Membership and Officers* X3/SD-6, April 1991.

Table F-4. (Continued)

U.S. Organization	Title	Standards Responsibility
COS	Corporation for Open Systems	Promote OSI; conformance testing
X/OPEN	X/OPEN	Promote portability and use of OSI
NIST	National Institute for Standards & Techology	Standards development and coordination; conformance
Workshops	Implementation Workshops	Develop design-to functional profiles
ASD(C3I)	Asst Sec Def C3I	
DASD C3	Deputy Assistant Secretary of Defense C3	
T&TC3	Theater and Tactical C3	Interoperability of C3 systems
IS	Information Systems	DoD transition to GOSIP
CIM	Corporate Information Management	Requirements and priorities for standards development
ASD(P&L)	Production and Logistics	
S&DS	Standardization & Data Management	Distribution of standards
DIA	Defense Intelligence Agency	
DISA (formerly DCA)	Defense Information Systems Agency	DoD Executive Agent for data comm protocol standards
DCS Organ	Defense Communications System Organization	
DCEC	Defense Communications Engineering Center	Lead on standards for long haul communications
JTC3A	Joint Tactical C3 Agency	Lead for tactical communication technical standards
JINTACCS	Joint Interoperability Tactical C2 Systems Program	Joint message standards
JMSWG	JTIDS Message System WG	TADIL J; J-Series messages and protocols
FSSG	Fire Support Subgroup	K-Series messages (and protocols)
JITF	Joint Interface Test Force	Testing Joint interfaces
JITC	Joint Interoperabilty Test Center	Testing Joint interfaces
CIM	Corporate Information Management	Developing Standards
JDSSC	Joint Data Systems Support Center	
WIS	WWMCCS Information System	
JSC	Joint Steering Committee	Develop common interoperability standards
PSSG	Protocol Standards Steering Group	Primary advisory body for standards policy issues
DTMP	DCPS Technical Management Panel	
DLA	Defense Logistics Agency	
DMSSO	Defense Materiel Specifications & Standards Office	
NSA	National Security Agency	
JCS J-6J	Joint Tactical C3 Systems Division	Ensure interoperability of TDSs
MCEB	Military Communications-Electronics Board	Coordinate representation to international standards bodies
USA DISC4	Director, Information Systems for C4	Technical requirements, interoperability
SAIS-ADO	RSI-Rationalization, Standards, & Interoperability	Interoperability and standards
DCSOPS	International RSI	Operational requirements, interoperability
PEO CCS	PEO Command & Control Systems	Interoperability of Army Tactical C2 Systems
PEO Comm	PEO Communications	Interoperability of Communications Systems
AMC	Army Materiel Command	Materiel standards
ICP-M	Office of International Cooperative Programs	
CECOM	Communications & Electronics Command	
ISD	Interoperability & Standardization Directorate	Technical support and POC for standards
TRADOC	Training and Doctrine Command	
CACDA	Combined Arms Combined Development Activity	Operational and procedural standards
SIGCEN	Signal Center	Communications standards
USAISC	Information Systems Command	
ISEC	Information Systems Engineering Command	
USN Info MGT	Information Management	
ASN RE&S/C3I&Space	C3I and Space	
CNO/SPAWAR	Space & Naval Warfare Systems Command	
CNO/Space,C2	Space & C2	
OP-945	Information Management Support	
NAVDAC	Naval Data Automation Command	
USMC MCRDAC SI	Systems Integration	Standards
MCCDC-WFC	Warfighting Center	Requirements
HQMC (C4I2) D4 Div P&I	Planning and Interoperability	Standards coordination
USAF AQ/DAS C4	Acquisitions—C4	
ACS C4 Sys	C4 Systems	
AF Comm Cmd	Communications Command	
AFSC	Air Force Systems Command	
ESD	Electronic Systems Division	
RADC	Rome Air Development Center	
TAC DRI	Tactical Air Command	

Table F-5. ANSI X3 Technical Committees [12]

X3A1	Optical Character Recognition	X3J11	C
X3B5	Digital Magnetic Tape	X3J12	DIBOL
X3B6	Instrumentation Tape	X3J13	LISP
X3B7	Magnetic Disks	X3J14	FORTH
X3B8	Flexible Disk Cartridges	X3J15	DATABUS
X3B9	Paper/Forms Layout	X3J16	C++
X3B10	Credit/Identificaton Cards	X3J17	Prolog
X3B11	Optical Digital Data Disks	X3J18	REXX
X3H2	Database	X3K5	Vocabulary
X3H3	Computer Graphics		
X3H4	Information Resource Dictionary System	X3L2	Codes & Character Sets
X3H5	Parallel Processing Constructs for High Level Programming Languages	X3L3	Picture Coding
		X3L8	Data Representation
X3J1	PL/1	X3S3	Data Communications
X3J2	BASIC		
X3J3	FORTRAN	X3T2	Data Interchange
X3J4	COBOL	X3T3	Open Distributed Processing
X3J7	APT	X3T4	Security Techniques
X3J9	PASCAL	X3T5	Open Systems Interconnection
X3J10	APL	X3T6	Non-Contact Information Systems Interface
		X3T9	I/O Interface
		X3V1	Text: Office & Publishing Systems
		X3W1	Office Machines

12 Updated from Accredited Standards Committee X3, Information Processing Systems, *Membership and Officers*, X3/SD-6, April 1991.

STATUS OF OPEN SYSTEMS STANDARDS DEVELOPMENT IN ISO/IEC [1]

1. INTRODUCTION

This appendix provides an overview of the work plans of selected technical committees and working groups in ISO/IEC. The purpose is to illustrate how rapidly international civil standards are being progressed in those areas applicable to ATCCIS. A compilation of ISO/IEC and CCITT standards relevant to ATCCIS is provided in Appendix D (by layer of the OSI Reference Model) and Appendix E (numerical listing). An overview of international standards bodies and their responsibilities for standards development is provided in Appendix F. The information in this Appendix is as of July 1990.

2. INFORMATION PROCESSING STANDARDS (JTC1)

Table G-1 provides an overview of the work plans for the major working groups of ISO/IEC JTC1 SC21, whose responsibility is Information Retrieval, Transfer, and Management for OSI. The standards bodies included in this table are:

- WG1 on OSI Architecture
- WG3 on Database
- WG4 on OSI Management
- WG5 on Specific Application Services
- WG6 on Session and Presentation Layers
- WG7 on Open Distributed Processing.

The symbols used in Table G-1 show the progress of a standard from its submission as a working draft (circulated to SC21), through the intermediate stages of committee draft (CD) or draft proposal (DP) and draft international standard (DIS), in becoming an international standard. In many areas, balloting as an international standard is planned for 1992 or earlier.

[1] Effective date of this Appendix is July 1990.

Table G-1. Status of Standards Development in ISO/IEC JTC1

WG1 OSI ARCHITECTURE	CURRENT STANDARD	1990	1991	1992
Database Management Systems	?			
OSI Basic Reference Model	ISO 7498	WD	DIS	ISO
Connectionless data transmission	AD1			
Multipeer data transmission (MPDT)	DAD2	SUSPENDED	SUSPENDED	
OSI Service conventions	TR 8509	DP/CD	DIS	ISO
Security architecture	ISO 7498-2			
Naming and addressing	DIS 7498-3			
Formal Description Techniques (FDTs)	-			
Estelle	IS 9074			
LOTOS	ISO 8807			
Conformance Testing Methodology and Framework	DIS 9646			
Part 1: General aspects	DIS 9646-1	ISO		
Part 2: Abstract test suite specifications	DIS 9646-2	ISO		
Part 3: TTCN	DIS 9646-3	ISO		
Part 4: Test realisation	DIS 9646-4	ISO		
Part 5: Requirements on Test Labs. and clients	DIS 9646-5	ISO		
Part 6: Multipart test tools and methods	DP 9646-6	DP/CD	DIS	ISO
Architectural Semantics for FDTs	SC21 N5116	DP/CD	DIS	ISO
Guidelines for Application of Estelle, LOTOS and SDL	DTR 10167	DIS		
Security Frameworks in Open Systems	DP 10181	DP/CD - - - - -	DP/CD DIS - - - -	- - - - - - DIS

WG3 DATABASE	CURRENT STANDARD	1990	1991	1992
Database Languages:	-			
NDL	ISO 8907			
SQL	ISO 9075			
SQL Addendum 1	AD1			
SQL 2	CD 9075.2	DIS		ISO
SQL 3	WD 9075.3		WD	DP/CD
Information Resource Dictionary System (IRDS):	-			
Framework	IS 10027	ISO		
Services Interface	SC21 N5147	WD	DP/CD	DIS
Export/Import	SC21 N5137	WD	DP/CD	DIS
Command language and panel interface	DP 8800-1		SUSPENDED	
Support for SQL 1 with integrity enhancement	ISO 9075			
Reference Model of Data Management	CD 10032.2	DP/CD	DIS	ISO
Technical report on model of data magement	SC21-4119		WD	DP/CD
Remote Database Access (RDA)	DP 9579-1		DIS	ISO
SQL specialization	DP 9579-2		DIS	ISO
SQL 2 specialization	WDAM-1		WD	DP/CD
Tutorial	SC21 N3343		DP/CD	DIS

Key: WD; DP/CD; DIS; ISO

Sources: Alan Paton, "Standard Status - SC21 Information Retrieval, Transfer, and Management for OSI," *OSN: The Open System Newsletter*, Volume 2, Issue 5, Technology Appraisals, Limited, London, July 1988 (used with permission); work plans provided in SC21 documents through July 1990; and private communication with Alan Paton, 19 July 1990.

Table G-1. (Continued)

WG4 OSI MANAGEMENT	CURRENT STANDARD	1990	1991	1992
OSI Management				
OSI systems management tutorial	SC21 N 4942	□		
OSI Management Information Service:	-			
System Management (SM) Overview	DIS 10040	▨	■	
Structure of management information	DIS 10165	▨	■	
Common information management service (CMIS)	ISO 9595	■		
Addendum 1,2: Cancel Get, Add/Remove	DAD 1,2	▨ ■		
Common info management protocol (CMIP)	ISO 9596	■		
Addendum 1,2: Cancel Get, Add/Remove	WDAD 1,2	▨ ■		
SM: Configuration management	DIS10164-1,2,3	▨	■	
SM: Fault management	DIS 10164-4-6	▨	■	
SM: Accounting management	DIS 10164-10	⊡	▨	■
SM: Performance management	DIS 10164-11	⊡	▨	■
SM: Security managemt	DIS 10164-7,8,9	⊡	▨	■
SM: Software management	DIS 10164-X		□	⊡
OSI The Directory	ISO 9594			
Part 1: Overview	ISO 9594-1			
Part 2: Information framework	ISO 9594-2			
Part 3: Abstract service definition	ISO 9594-3			
Part 4: Distributed operations	ISO 9594-4			
Part 5: Protocol specification	ISO 9594-5			
Part 6: Selected attribute types	ISO 9594-6			
Part 7: Selected object classes	ISO 9594-7			
Part 8: Authentication-framework	ISO 9594-8			
Part 9: DIT structure and naming	WD 9594-9	□ ⊡	▨	■
Part 10: Replication and knowledge management and addendum to parts 2, 3, 4, 5.	WD 9594-10	□ ⊡	▨	■
Addendum to Parts 1-7; support of nameform 2	PCDAMs		□ ⊡	▨
Addendum to Parts 2, 5, 6, 7: schema	PCDAMs	□ ⊡	▨	■
Addendum to Parts 2 ,3, 4, 5: access control	PCDAMs	⊡	▨	■

WG7 OPEN DISTRIBUTED PROCESSING	CURRENT STANDARD	1990	1991	1992
Open Distributed Processing (Reference Model)	SC21 N3192	(CD text expected June 1994)		

Key: □ WD ⊡ C[illegible]/CD ▨ DIS ■ ISO

Sources: Alan Paton, "Standard Status - SC21 Information Retrieval, Transfer, and Management for OSI," *OSN: The Open System Newsletter*, Volume 2, Issue 5, Technology Appraisals, Limited, London, July 1988 (used with permission); work plans provided in SC21 documents through July 1990; and private communication with Alan Paton, 19 July 1990.

Table G-1. (Continued)

WG5 SPECIFIC APPLICATION SERVICES	CURRENT STANDARD	1990	1991	1992
Operating System Command and Response Language	DP xxxx	INACTIVE		
OSCRL Overview	?			
OSCRL Specification	?			
Virtual Terminal Services and Protocols (VT)	-			
Basic class VT service	ISO 9040.2	ISO		
Add. 1 on extended facility set	AD 1	ISO		
Add. 2 on additional functional units	PDAD 2	DIS	ISO	
Basic class VT protocol	ISO 9041.2	ISO		
Add. 1 on extended facility set	AD1	ISO		
Add. 2 on additional functional units	PDAD 2	DIS	ISO	
Register of VT profiles	DIS 9834-4	DIS - - DIS	ISO	
Register of VT control objects	DIS 9834-5	DIS - - DIS	ISO	
File Transfer, Access and Management (FTAM)	ISO 8571			
Part 1: General description	ISO 8571-1			
Part 2: Virtual filestore	ISO 8571-2			
Part 3: File service definition	ISO 8571-3			
Part 4: File protocol specification	ISO 8571-4			
FTAM overlapped access - Parts 1,2,3,4,5	PDAD 2	DP/CD DIS	ISO	
FTAM Filestore management- Parts 1,2,3,4,5	DAM1	DIS	ISO	
FTAM PICS proforma	ISO 8571-5	ISO		
Job Transfer and Manipulation (JTM)	-			
Concepts and Services	ISO 8831			
Basic class protocol	ISO 8832			
Full class protocol	DAM1	DIS	ISO	
Checkpointing addendum	?	INACTIVE		
Registration of document types	DIS 9834-2	DIS - - DIS	ISO	
Transaction Processing (TP)	DIS 10026			
Model	DIS 10026-1	DIS	ISO	
Service	DIS 10026-2	DIS	ISO	
Protocol	DIS 10026-3	DIS	ISO	
Terminal Management (TM)	CD 10184			
Model	CD 10184-1	DP/CD	DIS	ISO
Service	WD 10184-2	WD - - - WD	DIS	ISO
Protocol	WD 10184-3	WD - - - WD	DIS	ISO
Conformance Test Suites for FTAM	DIS 10170			
Test suite structure and purpose	DIS 10170-1	DIS	ISO	
Abstract test suite	WD 10170-2	DP/CD	DIS	ISO
Abstract test suite embedded under FTAM	WD 10170-3		WD	DP/CD
Presentation abstract test suite embedded under FTAM	WD 10170-4		WD	DP/CD
Session abstract test suite embedded under FTAM	WD 10170-5		WD	DP/CD

Key: WD; DP/CD; DIS; ISO

Sources: Alan Paton, "Standard Status - SC21 Information Retrieval, Transfer, and Management for OSI," *OSN: The Open System Newsletter*, Volume 2, Issue 5, Technology Appraisals, Limited, London, July 1988 (used with permission); work plans provided in SC21 documents through July 1990; and private communication with Alan Paton, 19 July 1990.

Table G-1. (Continued)

WG6 OSI SESSION, PRESENTATION, AND APPLICATION SERVICE ELEMENTS	CURRENT STANDARD	1990	1991	1992
Data Descriptive File for Information Interchange	ISO 8211			
Upper Layer Architecture Addendum (ULA) to ISO 7498-1	PDAD3			
Session Layer Services and Protocols:	-			
Service definition	ISO 8326	■		
Protocol specification	ISO 8327	■		
Formal description of session	TR 9571, 72			
Symmetric sync addendum	AD 1	■		
Unlimited user data addendum	AD 2	■		
Session PICS proforma	CD 8327-2	⊡ ⧄	■	
Presentation Layer Services and Protocols:	-			
Service definition	ISO 8822			
Protocol specification	ISO 8823			
Specification for ASN.1	ISO 8824			
Addendum 1 to specifications for ASN.1	AD1			
Basic encoding rules for ASN.1	ISO 8825			
Addendum 1 to basic encoding rules	AD 1			
Symmetric synchronisation	WDAM 2	☐ ⊡	⧄	■
PICS proforma	DIS 8823-2	⧄	■	
Registration Authority Procedures	DIS 9834			
Part 1: General procedures	DIS 9834-1	⧄ - - - ⧄	■	
Part 2: OSI document types	DIS 9834-2	⧄ - - - ⧄	■	
Part 3: Object identifies component values	ISO 9834-3	■		
Part 4: VTE profiles	DIS 9834-4	⧄ - - - ⧄	■	
Part 5: VT control objects	DIS 9834-5	⧄ - - - ⧄	■	
Association Control Service Element (ASCE):	-			
Application layer structure (ALS)	ISO 9545	■		
Addendum for connectionless (CL) mode	WDAD 1	☐	⊡	⧄
Service definition for ACSE	ISO 8649			
Addendum on authentication	AD 1	■		
Addendum on A-context management	AM 2	■		
Commitment concurrency and recovery service (CCR)	ISO 9804.2	■		
Addendum on enhancements	CDAD 1	⊡	⧄	■
Addendum on restart	WDAD 3		☐	⊡
Specification of Protocols for ACSE:	-			
Protocol specification for ACSE	ISO 8650			
Addendum covering Authentication	DAD 1	■		
Addendum covering A-context management	AM 2			
Protocol amendment for PICS	DIS 8650-2	⧄	■	
Protocol amendment for application titles	DP 9834-6	⧄	■	
Commitment concurrency and recovery protocol (CCR)	ISO 9805.2	■		
Add. for checkpointing to CCR global restart points	AD 1			
Presentation of Numerical Values in Character Strings	?	INACTIVE		
Conformance Test Suites:	DIS 10168			
Session Part 1: Test suite structure and purposes	DIS 10168-1	⧄	■	
Session Part 2: Generic test suite	WD 10168-2			⊡
Session Part 3: Abstract test suite for CS Method	WD 10168-3		☐	⊡
Presentation Part 1: test suite structure and purpose	SC21 N5019	⊡ ⧄	■	
ACSE Part 1: Test suite structure and purpose	DIS 10169-1		■	
Session CL Protocol to Provide CL Mode	ISO 9548			
CL Addendum to the Session Service	ISO 8326 AD3			
CL Addendum to the Presentation Service	DIS 8822 AD1	■		
CL Presentation Protocol	ISO 9576	■		

Key: ☐ WD ⊡ DP/CD ⧄ DIS ■ ISO

Sources: Alan Paton, "Standard Status - SC21 Information Retrieval, Transfer, and Management for OSI," *OSN: The Open System Newsletter*, Volume 2, Issue 5, Technology Appraisals, Limited, London, July 1988 (used with permission); work plans provided in SC21 documents through July 1990; and private communication with Alan Paton, 19 July 1990.

INTERNATIONAL MILITARY AND OTHER STANDARDS BASED ON OSI STANDARDS OR USED IN OPEN SYSTEMS PROFILES

I. NATO STANDARDS

A. OSI STANAGs

STANAG 4250♦	NATO Reference Model for OSI, NATO UNCLASSIFIED
STANAG 4250-1♦	Part 1--General Description, Revised Draft, May 1990, NATO UNCLASSIFIED
STANAG 4250-2♦	Part 2--Security, Draft (SANISI Document), NATO SECRET
STANAG 4250-3♦	Part 3--Naming and Addressing, Draft (Working Paper), NATO UNCLASSIFIED
STANAG 4250-4♦	Part 4--Management, Draft (Working Document), NATO UNCLASSIFIED
STANAG 4250-5♦	Part 5--Military Features, Draft (Working Document), NATO UNCLASSIFIED
STANAG 4251♦	NATO Reference Model for OSI - Layer 1 (Physical Layer) Service Definition, Draft, 13 July 1990, NATO UNCLASSIFIED
STANAG 4252♦	NATO Reference Model for OSI - Layer 2 (Data Link Layer) Service Definition, Draft, 6 July 1990, NATO UNCLASSIFIED
STANAG 4253♦	NATO Reference Model for OSI - Layer 3 (Network Layer) Service Definition, Draft, July 1990, NATO UNCLASSIFIED (Appendix B is NATO CONFIDENTIAL)
STANAG 4254♦	NATO Reference Model for OSI - Layer 4 (Transport Layer) Service Definition, Draft, July 1990, NATO UNCLASSIFIED
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RFC 862	Echo Protocol
RFC 863	Discard Protocol
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RFC 867	Daytime Protocol
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ANSI X3.108	Information Systems - Local Distributed Data Interfaces (LDDI) - Physical Layer Interface to Nonbranching Coaxial Cable Bus, 1988
ANSI X3.109	Physical Layer Protocol for Local Distributed Data Interfaces (LDDI), 1982 (DP)
ANSI X3.110	Videotex/Teletext Presentation Level Protocol (North American PLPS), (FIPS 121) 1983 [ISO 6937/1-2]
ANSI X3.113	Full BASIC, 1987 (FIPS 68-2) [DP 10279]
ANSI X3.113A	Addendum to Programming Language Full BASIC, Modules and Individual Character Input, 1989
ANSI X3.122	Computer Graphics Metafile (CGM) for the Storage and Transfer of Picture Description Information, 1986 (REPLACED by ISO 8632)
ANSI X3.122.5	LISP Binding of GKS, Draft, 1989
ANSI X3.123	Programming Language APL, Draft, 1989 (DP 8485)
ANSI X3.124	Computer Graphics - Graphical Kernel System (GKS) Functional Description, 1985 (ISO 7942) [undergoing reaffirmation]
ANSI X3.124.1	Computer Graphics - Graphical Kernel System (GKS) FORTRAN Language Binding, 1985 (ISO 8651-1) [undergoing reaffirmation]
ANSI X3.124.2	Computer Graphics - Graphical Kernel System (GKS) Pascal Language Binding, 1988 (ISO 8651-2)
ANSI X3.124.3	Computer Graphics - Graphical Kernel System (GKS) Ada Language Binding, 1989 (ISO 8651-3)
ANSI X3.124.4	Computer Graphics - Graphical Kernel System (GKS) C Binding, Draft, 1989 (DP 8651-4)
ANSI X3.129	Intelligent Peripheral Interface, Physical Level, 1986 [ISO 9318-1]
ANSI X3.130	Intelligent Peripheral Interface - Device-Specific Command Set for Magnetic Disks, 1986 [ISO 9318-2]
ANSI X3.131	Small Computer System Interface (SCSI), 1986 [ISO 9316]
ANSI X3.132	Intelligent Peripheral Interface - Device Generic Command Set for Magnetic and Optical Disks, 1986 [ISO 8907]
ANSI X3.133	Database Language NDL, 1986 (FIPS 126)
ANSI X3.134.1	8-Bit ASCII Structure and Rules, Draft
ANSI X3.134.2	7-Bit and 8-Bit ASCII Supplemental Multilingual Graphic Character Set (ASCII Multilingual Set), Draft
ANSI X3.135	Database Language SQL, 1989 (FIPS 127) [relational database application program interface] (ISO 9075)
ANSI X3.135.1	Database Language SQL - Addendum 1: Integrity Enhancement Feature, 1988 (ISO 9075 DAD1)
ANSI X3.138	Information Resource Dictionary System (IRDS), 1988 (DIS 10027) (FIPS 156)
ANSI X3.138A	Supplement to X3.138-1988, Information Resource Dictionary System (IRDS), 1991
ANSI X3.139	Fibre Distributed Data Interface (FDDI) Token Ring Media Access Control (MAC), 1987 [DP 9314-2]
ANSI X3.140	Information Processing Systems - Open Systems Interconnection - Connection Oriented Transport Layer Protocol Specification, 1986 (ISO 8072 and 8073)
ANSI X3.141	Data Communication Systems and Services - Measurement Methods for User-Oriented Performance Evaluation, 1986
ANSI X3.143	Information Processing Systems - Text and Office Systems - Standard Generalized Markup Language (SGML), Draft [ISO 8879]

ANSI X3.144	Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Functional Description, September 1988 (ISO 9592, 9593)
ANSI X3.144.1	ANS for the FORTRAN Language Binding of the Programmer's Hierarchical Interactive Graphics System (PHIGS) Binding to FORTRAN, 1989 (ISO 9593-1)
ANSI X3.144.2	Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Binding to Pascal, Draft, 1987 (DP 9593-2)
ANSI X3.144.3	Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) Binding to Ada, 1989 [DIS 9593-3]
ANSI X3.144.4	Computer Graphics - Programmer's Hierarchical Interactive Graphics System (PHIGS) C Language Binding, Draft, September 1988 (DP 9593-4)
ANSI X3.146	Streaming Cartridge and Cassette Tape Drives - Device-Level Interface, 1986
ANSI X3.147	Intelligent Peripheral Interface - Device Generic Command Set for Magnetic Tape, 1987 [ISO 9318-4]
ANSI X3.148	Fibre Distributed Data Interface (FDDI) - Physical Layer Protocol (PHY), 1988 (ISO 9314-1)
ANSI X3.153	Open Systems Interconnection - Basic Connection Oriented Session Protocol Specification, 1987 (ISO 8327)
ANSI X3.159	Information Systems - Languages - Programming Language C, 1989 (ISO 9899: 1990; FIPS-160)
ANSI X3.160	Programming Language Extended Pascal, 1989 (DP) [ANSI/IEEE 770 X3.160-1989]
ANSI X3.161	Computer Graphics Interface (CGI), 1990 [REPLACED BY ISO 9636)
ANSI X3.166	Fibre Distributed Data Interface (FDDI) - Physical Layer Medium Dependent (PMD), 1990 [ISO 9314-3]
ANSI X3.167	Local Distributed Data Interface (LDDI) Star-Wired Physical Interface Sublayer, 1987 (DP)
ANSI X3.168	Information Systems - Language - Embedding of SQL Statements into Programming Languages, 1989
ANSI X3.170	Information Systems - Data Communication - Enhanced Small Device Interface (ESDI), 1990 [DIS 10222]
ANSI X3.172	American National Standard Dictionary for Information Systems, Draft, August 1988 (DP)
ANSI X3.176	Intelligent Peripheral Interface - Logical Device-Specific Command Set for Magnetic Tapes, 1989, [ISO 9318-5]
ANSI X3.177	Intelligent Peripheral Interface - Device Generic Command Set for Communications, 1990, [ISO 9318-7]
ANSI X3.184	Fibre Distributed Data Interface (FDDI) Physical Layer Medium Dependent (SMF-PMD) (CD 9314-4)
ANSI X3.185	IRDS Software Interface, Draft
ANSI X3.190	Conformance Testing for SGML Systems, Draft, April 1991
ANSI X3.194	Database Language SQL2, Draft
ANSI X3.196	Computer Graphics - X Window System Data Stream Definition, Draft
ANSI X3.198	Programming Language FORTRAN Extended (FORTRAN 9X), Draft [DIS 1539] estimated completion 1991
ANSI X3.208	Transfer Syntax Description Notation, 1991
ANSI X3H4.6	Technical Report on Model Unification for Data Repositories

ANSI X3S3.7	X.25 Data Transfer Phase Procedures for Operating the Packet Layer Transfer Phase of X.25
ANSI X3V1.4	Voice Messaging over MOTIS ISO/DIS 10021
ANSI X3V1.9	Standard User Interface to Voice Messaging
ANSI X3 682-D	Domestic Public/Private X.25 Network Interworking, Draft
ANSI X12	Electronic Data Interchange (ISO 9735)
HFS/ANSI 100-1988	Human Factors Engineering of Video Display Terminal Workstation Standard, 1988
IEEE 610.12	IEEE Standard Glossary of Software Engineering Terminology , 1990.
ANSI/IEEE 730	IEEE Standard for Software Quality Assurance Plans, 1984 (Revision underway)
IEEE 770	Programming Language Pascal, 1990
IEEE 802.1D	IEEE Standards for Local and Metropolitan Area Networks: Media Access Control, 1990
IEEE 802.1E	IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications: Layer Management (Section 5). 1990
IEEE 802.3h	IEEE Standards for Local and Metropolitan Area Networks: System Load Protocol, 1990
IEEE P802.10A	Interoperable LAN Security (SILS) - The Model [PAR approved 5/90]
IEEE P802.10B	SILS - Secure Data Exchange [PAR approved 5/90]
IEEE P802.10C	SILS - Key Management [PAR approved 5/90]
IEEE P802.10D	SILS - Security Management [PAR approved 5/90]
IEEE P802.11	Standard for Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specificaitons [PAR approved March 21, 1991]
IEEE P828	Standard for Software Configuration Management Plans, 1983 (PAR revised 28 September 1990[4]) [PAR WITHDRAWN 6 December 1990[5]]
ANSI/IEEE 829	IEEE Standard for Software Test Documentation, 1983 (Standard reaffirmed March 21, 1991])
ANSI/IEEE 830	IEEE Guide to Software Requirements Specifications, 1984 (Revision underway)
IEEE 928.1	IEEE Standard Dictionary of Measures to Produce Reliable Software, 1988
IEEE 928.2	IEEE Guide for the Use of IEEE Standard Dictionary of Measures to Produce Reliable Software, 1988
ANSI/IEEE 983	IEEE Guide for Software Quality Assurance Planning, 1986
ANSI/IEEE 990	IEEE Recommended Practice for Ada as a Program Design Language, 1986
ANSI/IEEE 1002	IEEE Standard Taxonomy for Software Engineering Standards, 1987
IEEE P1003.0	POSIX Guide (Draft 11, March 1991 to be balloted in February 1992)
IEEE P1003.1	POSIX - System Interface (approved by ANSI in November 1989 and revised September 1990; approved by ISO as ISO 9945-1, December 1990. IEEE IEEE P1003.1-1988 approved as FIPS 151-1, March 1990.

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4 Updated from *The IEEE Standards Bearer*, vol. 4, no. 3, October 1990, pp. 8-9.

5 Updated from *The IEEE Standards Bearer*, vol. 4, no. 4, December 1990, pp. 8-9.

IEEE P1003.1a	Language Independent Specifications (Draft 5, December 1990) (Ballot spring 1992; target completion late 1992) [ISO 9945-1]
IEEE P1003.1b	System Interface Extensions (Draft 5, December 1990) (IEEE balloting planned for late 1991.) [DP 9945-1.2]
IEEE P1003.2	Shell and Utilities (Draft 11 balloted February 1991) (IEEE standard expected late-1991 to early 1992) (Draft 10 was submitted to ISO and balloted as DP 9945-2, but failed.)
IEEE P1003.2a	User Portability Extensions. (Draft 6 balloted March 1991) (IEEE standard expected late-1991 to early 1992) [DP 9945-2.2]
IEEE 1003.3	Test Methods: General (IEEE 1003.3-1991 approved March 21, 1991)
IEEE P1003.3.1	Test Methods: System Interfaces. (Draft 12 balloted April 1991; approval of final text expected late in 1991 to early 1992.)
IEEE P1003.3.2	Test Methods: Shell and Utilities. (Draft 4, February 1991; to be balloted mid-1992; approval of final text expected early 1993.)
IEEE P1003.4	Real-Time Extensions. (Draft 10 balloted February 1991; approval expected late 1991)
IEEE P1003.4a	Threads. (Draft 5, November 1990 balloted January 1991.)
IEEE P1003.4b	Language-Independent Specifications
IEEE P1003.4c	Extensions to IEEE P1003.4 (Draft 10, January 1991; balloting planned for 2Q 1991.)
IEEE P1003.5	Ada Language Binding (Draft 7 balloted June 1990; approval expected in 1Q 1992)
IEEE P1003.6	Security Interface for POSIX (Draft 10, March 1991; Draft 11 balloted May 1991; approval expected mid-1992)
IEEE P1003.7	System Management (name changed from System Administration Interface) (Draft 5, February 1991; ballot planned for April 1992) [DP 9945-3.1]
IEEE P1003.8	Transparent File Access (TFA). (Draft 4, November 1990; balloting planned for summer 1991.) [DP 9945-1.3.1]
IEEE P1003.9	FORTRAN Language Binding (Work based on results of /usr/group; Draft 8 balloted November 1990)
IEEE P1003.10	Supercomputing Application Environment Profile (AEP) (Draft 5, March 1991) [DP 9945-3.2]
IEEE P1003.11	Transaction Processing (Draft 2, March 1991; mock ballot planned for January 1992; ballot expected mid-1992) [DP 9945-1.3.3]
IEEE P1003.12	Protocol Independent Interfaces. (Working pre-draft January 1991; balloting planned for 1992.)
IEEE P1003.13	Real-Time AEP. (Draft 1, April 1990; balloting planned for early 1991.) [DP 9945-1.3.4]
IEEE P1003.14	Multiprocessing Application Support AEP (Draft 2, January 1991; balloting planned for October 1991.)
IEEE P1003.15	Batch Environment Amendments (Draft 5, January 1991, balloting planned for July 1991.)
IEEE P1003.16	C Language Binding (balloting expected Fall 1991)
IEEE P1003.17	Directory Services API. (Draft 0, January 1992; balloting planned for 1992)
IEEE P1003.18	POSIX Platform Profile (Group formed October 1990, Draft 3, January 1991)
ANSI/IEEE 1008	IEEE Standard for Software Unit Testing, 1987
ANSI/IEEE 1012	IEEE Standard for Software Verification and Validation Plans, 1987
ANSI/IEEE 1016	IEEE Recommended Practice for Software Design Descriptions, 1987

IEEE 1028	IEEE Standard for Software Reviews and Audits, 1988
ANSI/IEEE 1042	IEEE Guide to Software Configuration Management, 1988
IEEE P1044	Classification of Software Errors/Faults/Failures
IEEE P1045	Software Productivity Metrics
ANSI/IEEE 1058.1	IEEE Standard for Software Project Management Plans, 1987
IEEE P1058.2	Guide for Software Project Management Plans [PAR WITHDRAWN March 21, 1991]
IEEE P1059	Software Verification and Validation
IEEE P1061	Software Quality Metrics Methodology
IEEE P1062	Software Acquisition
ANSI/IEEE 1063	IEEE Standard for Software User Documentation, 1989
IEEE P1074	Software Life Cycle Processes, Draft
IEEE P1074.1	Guide for Developing Software Life Cycle Processes (PAR approved 6 December 1990)
IEEE P1172	Object Oriented Programming Language and Environment, Draft
IEEE P1178	SCHEME Language Standard, [Standard approved 6 December 1990]
IEEE P1201.1	Window Interface for User Application and Portability, Draft
IEEE P1201.2	Recommended Practice on Driveability (balloting expected last quarter 1992)
IEEE P1209	Recommended Practice for Evaluation of CASE Tools, Draft
IEEE P1219	Software Maintenance Standard
IEEE P1224	X.400 and Directory Services API [ballot planned for mid-1991]
IEEE P1228	Software Safety PlansANSI/IEEE 729 IEEE Standard Glossary of Software Engineering Terminology, 1983
IEEE P1237	Remote Call Procedure Interface Language, PAR approved May 1990
IEEE P1238	OSI Aplication Program Interfaces (Group formed January 1990; PAR approved May 1990; Draft 4 to be balloted January 1992)
IEEE P1238.1	OSI Application Program Interfaces, File Transfer, Access and Management (FTAM), (Group formed January 1990; PAR approved May 1990; ballot planned for 1993)
IEEE P1252	Standard for an Open Architecture for Knowledge Presentation (PAR approved 6 December 1990)
IEEE P1256	Standard for an Open Basic Input/ouptut System Software (OBIOS), [PAR approved March 21, 1991]

FIPS 121	Videotext/Teletext Presentation Level Protocol Syntax (PLPS), (ANSI X3.110)
FIPS 127	Database Language SQL, 10m March 1987, [ANSI X3.135-1986]
FIPS 128	Computer Grpahics Metafile, 16 March 1987, [ANSI X3.122-1986]
FIPS 146-1	Government Open Systems Interconnection Profile (GOSIP), FIPS 146-1,Version 2.0, U.S. National Institute of Standards and Technology, 3 April 1991
FIPS 151	POSIX, 12 September 1988 [IEEE 1003.1]
FIPS 152	SGML, 26 September 1988 [ISO 8879-1986]
FIPS 156	Information Resource Directory System (IRDS), 05 April 1989 [ANSI X3.138-1988]
FIPS 160	Information Systems - Languages - Programming Language C, 1989 (ISO 9899: 1990; ANSI X3.159)

Stable Agreements	Stable Implementation Agreements for Open Systems Interconnection Protocols, Version 2, Edition 1, NIST Special Publication 500-16, National Institute of Standards and Technology, December 1988 (basis for U.S. GOSIP 1.0)
Stable Agreements	Stable Implementation Agreements for Open Systems Interconnection Protocols, Version 3, Edition 1, NIST Special Publication 500-177, National Institute of Standards and Technology, March 1990 (Proceedings of December 1989 NIST OSI Implementor's Workshop; basis for U.S. GOSIP 2.0)
Working Agreements	Working Implementation Agreements for Open Systems Interconnection Protocols: Continuing Agreements, Volume 2, Number 2, NISTIR 90-4247, National Institute of Standards and Technology, February 1990 (Proceedings of December 1989 NIST OSI Implementor's Workshop)
Yellow Book	Computer Security Requirements--Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments (Yellow Book), CSC-STD-003-85, DoD Computer Security Center, June 1985
Yellow Book Rationale	Technical Rationale Behind CSC-STD-003-85: Computer Security Requirements--Guidance for Applying the Department of Defense Trusted Computer System Evaluation Criteria in Specific Environments, CSC-STD-004-85, DoD Computer Security Center, June 1985
Orange Book	Department of Defense Trusted Computer System Evaluation Criteria (Orange Book), DoD 5200.28-STD, DoD Computer Security Center, December 1985
Red Book	Trusted Network Interpretation (Red Book), NCSG-TG-005, Version 1, National Computer Security Center, July 1987
SDN.301	Secure Data Network System (SDNS) Security Protocol 3 (SP3), Revision 1.5, SDNS Protocol and Signalling Working Group, 15 May 1989, National Security Agency, UNCLASSIFIED
SDN.401	Secure Data Network System (SDNS) Security Protocol 4 (SP4), Revision 1.3, SDNS Protocol and Signalling Working Group, 2 May 1989, National Security Agency, UNCLASSIFIED
SDN.601	Secure Data Network System (SDNS) Key Management Profile, Communication Protocol Requirements for Support of the SDNS Key Management Protocol, Revision 1.5, SDNS Protocol and Signalling Working Group, 11 August 1989, National Security Agency, UNCLASSIFIED
SDN.701	Secure Data Network System (SDNS) Message Security Protocol (MSP), Revision 1.5, SDNS Protocol and Signalling Working Group, 1 August 1989, National Security Agency, UNCLASSIFIED
SDN.702	Secure Data Network System (SDNS) Directory Specifications for Utilization with the SDNS Message Security Protocol (MSP), Revision 1.4, SDNS Protocol and Signalling Working Group, 1 August 1989, National Security Agency, UNCLASSIFIED
SDN.801	Secure Data Network System (SDNS) Access Control Concept Document, Revision 1.3, SDNS Protocol and Signalling Working Group, 26 July 1989, National Security Agency, UNCLASSIFIED
SDN.802	Secure Data Network System (SDNS) Access Control Specification, Revision 1.0, SDNS Protocol and Signalling Working Group, 25 July 1989, National Security Agency, UNCLASSIFIED
SDN.802/1	Secure Data Network System (SDNS) Access Control Specification, Addendum 1, Access Control Information Specification (ACIS), Revision 1.0, SDNS Protocol and Signalling Working Group, 25 July 1989, National Security Agency, UNCLASSIFIED

SDN 902 Secure Data Network System (SDNS) Key Management Protocol, Definition of Services Provided by the Key Management Application Service Element (KMASE), Revision 3.2, SDNS Protocol and Signalling Working Group, 1 August 1989, National Security Agency, UNCLASSIFIED

SDN 903 Secure Data Network System (SDNS) Key Management Protocol, Specification of the Protocol for Services Provided by the Key Management Application Service Element (KMASE), Revision 3.2, SDNS Protocol and Signalling Working Group, 1 August 1989, National Security Agency, UNCLASSIFIED

SDN 906 Secure Data Network System (SDNS) Key Management Protocol, SDNS Traffic Key Attribute Negotiation, Revision 1.3b, SDNS Protocol and Signalling Working Group, 18 September 1989, National Security Agency, UNCLASSIFIED

STATUS OF WORK ON LOWER-LAYER OSI STANAGS[1]

1. OVERVIEW

TSGCE SG9 has the primary responsibility in NATO for reviewing the military requirements, identifying the potential impact on the OSI standards planned for use in each of the seven layers of the ISO and NATO Reference Model, defining the deficiencies and services required to address these requirements at each layer, and developing draft STANAGs that conform to the Reference Model and provide for the needed services. SG9 has three permanent WGs, one of which is not permanent, and three ad hoc working groups (AHWGs):

- WG1, responsible for Layers 1-4 and functional profiles
- WG2, responsible for Layers 5-7, within which the work on the Military Message Handling System (MMHS) is carried out by an AHWG on MMHS.
- WG3, responsible for establishing a memorandum of understanding (MOU) for a multinational programme for Communications Systems Network Interoperability (CSNI)--not a permanent WG; work on the MOU is expected to be completed in December 1990, at which time WG3 would be disbanded.
- AHWG on OSI Management (AHWG-OM).
- AHWG on Integrated Services Digital Network (ISDN).
- AHWG on Security.

A major project of TSGCE SG9, led by the German delegation, is the development and maintenance of the *NTIS Transition Strategy*. The current version is the 1989 or Fifth Edition; it is dated 30 November 1989 [Purton 1987] and was directed to be distributed by SG9 in May 1990. This document is revised annually and promulgated by the CNAD. It provides recommendations for international commercial standards, primarily from ISO and CCITT, and intercept strategies (stacks of standards) that can be used by the nations as part of a transition strategy prior to the promulgation of OSI STANAGs. The *Intercept Profile for Military Message Handling Systems*, based on CCITT X.400-MHS(84) (see Appendix K), was included in this edition. The Fifth Edition also incorporates ISDN standards and the 1988 recommendations of CCITT. It describes 4 application, 17 transport, and 11 relay profiles. It also addresses many of the deficiencies identified in the July 1989 release (Version 1.2) of WP 25, including ODA, RDA, and TP. A summary of the standards and profiles contained in the Fifth Edition of the *NTIS Transition Strategy* is provided in Section 6.3.1, especially Tables 14, 15, and 16 and Figure 7. The profiles are illustrated in Appendix B.

A draft of the next edition of the *NTIS Transition Strategy* was expected to have been distributed in final form after the May 1991 SG9 meeting. The new version will include use of the new ISO TR 10000 taxonomy. The taxonomy of application profiles is expected to be removed from the *NTIS Transition Strategy* and included in the Functional Profile Guidelines document being developed in WG1. Emerging standards not addressed in the Fifth Edition that should be considered for the next edition of the *NTIS Transition Strategy* are ODP, TM, security protocols, X-Protocol (X-Windows), GKS, CGI, PHIGS, CGM, SQL, IRDS, and Remote Call Procedure.

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[1] Effective date of this Appendix is July 1990.

2. STATUS OF WORK ON LOWER LAYER OSI STANAGs

The two primary tasks of WG1 are developing lower layer STANAGs (the first issues were planned for submission to SG9 in October 1990) and developing guidelines for standardizing NATO functional profiles. The status of these activities is summarized below [Schultz 1990; WG/1 1989; WG/1 1989a].

2.1 Lower Layer STANAGs

WG1 has agreed to prepare all the lower layer STANAGs for submission to SG9 by the October 1990 WG1 meeting. If possible, example profiles, Conformance Statements, and NPICS Proforma will be included. At present, the draft STANAGs do not explicitly require Transport Protocol TP4 to support connectionless operations, and they may not include the annex for Layer 3 (Annex F) on the connectionless Internet Protocol (IP). Revised drafts of all STANAGs are planned for the July 1990 meeting of the AHWG-FP. WG1 has determined [WG/1 1989b] that it is inappropriate for forward error correction (FEC) to be standardized with the OSI framework; therefore, WG1 has relegated FEC as actions to be accomplished on the information bit stream outside the Reference Model. Thus, FEC is not currently being considered in the lower layer STANAGs.

2.2 Functional Profiles

A Functional Profile (FP) Guidelines document is being developed; it is viewed in WG1 as the basis for the lowest common denominator of interoperability. This document is being developed in WG1, but WG2 will be requested to provide formal comments and will be invited to participate in future AHWG-FP meetings. The FP Guidelines document is based on ISO TR 10000 (Part 1--*Framework* and Part 2--*Taxonomy*). WG2 has no strong reservations against the FP Guidelines or the ISO TR 10000 taxonomy and structure for standardized profiles. However, WG2 expressed the need to continue their message handling work in the EWOS format in order to maximize their interchange of information with EWOS. WG2 would translate their MMHS STANAG work into the TR 10000 structure at a time when that structure was more stable for the upper layers.

2.3 Use of OSI in NATO

WG1 is evaluating a proposal to change the emphasis of SG9 work on military features. The paper, *NATO Approach to OSI--A Review*, says that

> With the possible exception of the work on management however, the analysis of the current ISO position indicates that there is relatively little scope remaining for NATO to influence ISO to provide specific military features.[2] Therefore, we need to focus our work on the facilities that are now present and examine how they should be adapted for use. ...there is a need now to develop augmentations to the civil standards.

WG1 agreed that work should be done to adapt present facilities for military use, but that many aspects of the identified military features cannot be satisfied by the present facilities and that additions must be made to the current protocol standards. WG1 further agreed that is desirable to amend the civilian OSI standards under development to incorporate military features if that it is possible. Finally, WG1 agreed that this represents a shift in emphasis in the WG1 work, but not to the exclusion of having NATO-approved positions presented to ISO. The *NATO Approach to OSI--A Review* paper addresses the military features as shown in Table I-1.

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2 This view is not shared by all of TSGCE SG9; both the AHWG on Security and the AHWG on OSI Management are continuing to work to influence ISO to provide military features. In security, work is continuing to make the TCS conform to the eventual security protocol agreed by ISO---only the implementation would be unique to NATO.

Table I-1. Proposed New Emphases for TSGCE SG9 Work on Military Features

(1)	Multihomed and mobile systems. The routing protocols are deemed likely to meet the military requirements. Further work in NATO is needed to establish exactly how these protocols are to be used. Additionally, further study is needed for use of the Directory service, if adopted by NATO, to meet these requirements by providing a mapping to multiple addressees.
(2)	MPDT. ISO work on multi-endpoint connections is likely to be set aside. Support of this feature for time-critical applications could be considered along with the work on real- time and tactical communications, or it can be considered as a pan-layer topic in its own right. SG9 should therefore assume the responsibility for developing this work as an augmentation to civil standards as a minimum to define a broadcast facility for use when the physical media is inherently of a broadcast nature.
(3)	Internetworking. Work is needed to meet the military requirement for secure internetworking between connection based and connectionless environments.
(4)	Security. NATO is currently further ahead than ISO on security. The work to develop the Trusted Communications Sublayer (TCS) protocols, which are unique to NATO and outside of OSI as a matter of choice, must continue. Further work is required to develop the security functionality at the other layers identified within NOSA... Interaction with the civil standards community is anticipated.
(5)	Robustness and Quality of Service. Little work has been done in ISO on fully supporting QoS. ... Much excellent work to define the military requirements for QoS has already taken place but it needs to be refined and developed as augmentations to layer protocols. ... It is an area, like management, where input to ISO could be made if the topic is pursued there. ... At the sub-network level, robustness may be supported through exploiting facilities within the emerging ISO routing protocols.
(6)	Precedence and Preemption. The ISO protocols to convey precedence and pre-emption need augmentation to define the number of military levels and how they are signalled between the layers in a consistent manner.
(7)	Real-time. Studies are required to examine the protocol overheads associated with current profiles (e.g., MMHS over STAMINA). It may be necessary to cut down the OSI stack for some profiles (e.g., support of wide area networks).
(8)	Management. Work is required to identify, define, and register military objects that need to be managed by means of the emerging OSI management mechanisms.

Source: *NATO Approach to OSI--A Review,* U.K. Contribution to WG1, October 1989, NATO UNCLASSIFIED.

2.4 Multipeer Data Transmission (MPDT)

Work is progressing in the U.S. Protocol Standards Technical Panel for multicasting; [now the Data Communications Standards (DCPS) Technical Management Panel (DTMP). Canada is working to keep MPDT alive in ISO and is coordinating other NATO-Nation input with ISO. See Section 3.3 and Appendix K.

2.5 Lower Layer Addressing

WG1 has been reviewing a number of technical papers on lower layer addressing. These include the *EWOS Technical Guide to OSI Layer 1 Through 4 Addressing* and a draft British Standards Institute guide for *The U.K. Scheme for the Allocation of ISO-DCC Format OSI Network Service Access Point (NSAP) Addresses,* which was used in the EWOS document as a reference for addressing in Layer 3. The U.S. has submitted papers on naming and addressing and on the compatibility of STANAG 4214 and U.S. GOSIP Network Layer addressing. The U.K. has developed a rationale for Annex D of draft STANAG 4263 with the goal of resolving differences with STC in an addressing scheme.

2.6 Precedence and Preemption

Since ISO restricts the Transport Layer levels of precedence to 15 by restricting use of one of the levels, WG1 agreed to reduce from 16 to 15 the number of levels of precedence that would be adequate at the Transport Layer.

2.7 Real-Time Programs

WG1 has specific proposals for incorporating real-time aspects into the Layer 4 STANAGs. There are issues regarding these real-time services as to their conformance to OSI, differences from CCITT real-time work, and the interest of several nations in other efforts [e.g., U.S. Manufacturing Automation Protocol (MAP) real-time work] as closer to OSI.

2.8 Glossary of Terms

WG1 has developed a *Glossary for OSI Layers 1 Through 4*. WG1 is recommending to SG9 that SG9 coordinate a glossary for all OSI layers.

2.9 Liaison With Other Groups

The *NATO Consultation, Command and Control (C3) Master Plan* developed by NACISA is being forwarded to the Military Committee and is expected to be approved. The *NATO C3 Architecture* is still being worked on; in particular, Volume 1 (*Consolidated Architecture*) has not been accepted (see Appendix K). STC has an ongoing program to implement X.25 for an investigation of preemption functionality. US/EUROCOM wishes to use STANAGs 4262 and 4263 for the revised STANAG 4269 on the tactical digital gateway but reports that the layer STANAGs were not considered stable enough. WG1 has noted that the gateway standard would appropriately be a profile of SG9 lower layer standards, probably a relay profile. WG1 has responsibility for access to ISDN and plans on developing profiles for use of ISDN as a bearer service.

2.10 Work Plan

TSGCE SG9 WG1 18-month work plan, beginning October 1989, is shown in Table I-2. [WG/1 1989].

Table I-2. Work Plan and Activities on Lower Layer STANAGs by WG1

(1)	Develop annexes to Layers 1-4 STANAGs, incorporating the applicable NATO military features; focus on MPDT and the TC 111(M) Profile, Connection-Oriented Transport Protocol (TP0/TP2) over X.25 (complete by September 1990).
(2)	Submit Layer 1-4 STANAGs to SG9 for ratification (October 1990).
(3)	Finalize and submit for ratification the Functional Profile Guidelines document for submission to SG9 in October 1990.
(4)	Finalize ongoing work on the TC 111(M) and R.131(M) functional profiles (drafts for July 1990; refer to SG9 after the September 1990 WG1 meeting).
(5)	Continue development of the TA 51(M) LAN profile (no target dates for completion).
(6)	Develop NATO military scenarios to provide a basis for future functional profiles, for use by all working groups (September 1990).
(7)	Develop addressing protocols.
(8)	Develop broadcast protocols (STANAGs) for tactical radios.
(9)	Develop STANAGs to support real-time communications.
(10)	Study gateways between tactical and strategic networks.
(11)	Study feasibility of ISDN in a NATO military environment (note: WG1 addresses only the requirements to access/interface to ISDN).
(12)	Study aspects such as use of routing protocols (especially with regard to multihomed and mobile host systems), multipeer (multi-endpoint) communications, internetworking, quality of service (including priority and preemption), and military-specific managed objects.
(13)	Maintain liaison with NIAG(SG6) in their development of functional profiles.

Source: *NATO SG9 WG1 18-Month Work Plan*, TSGCE SG9 WG1, October 1989, NATO UNCLASSIFIED.

3. STATUS OF ACTIVITIES AND PLANS FOR DEVELOPING UPPER LAYER OSI STANAGs

The status of WG2 activities is summarized in the following paragraphs [TSGCEE 1989; WG/2 1990]:

3.1 Upper-Layer STANAGs

The first issues of the STANAGs for the Session Layer, the Presentation Layer, and ASN.1 have been submitted to SG9 without any military enhancements. Some minor changes were made in February 1990. Some additional editorial changes were directed by SG9 in May 1990 and action to begin ratification is deferred. WG2 will make the required changes in October 1990, and the ratification process was expected to be directed to begin by SG9 in December 1990.

3.2 Registration Authority

NATO needs to make provision for an appropriate registration authority to ensure unique addressing of military organizations and users within NATO MMHS domains and to assign object identifiers for MMHS (and other application service element) information objects. Registration authority can be technically independent for Application Layer addressing and information objects and for network addresses, but NATO may wish to consider these two issues concurrently.

Two principal scenarios are being discussed, one in which NATO is registered as a network addressing authority under the ISO 6523 scheme and allocates Network Service Access Point (NSAP) address space to users, and another in which NATO is *not* so registered and each member nation allocates from its own delegated address space the NSAP address space for NATO use. It has been noted [Ref. 253]

that if NATO becomes a network addressing authority, it will not prejudice the ultimate choice of which scenario to pursue and that such authority is needed for reasons other than NSAP addresses.

SG9 has considered recommendations drafted by the AHWG on MMHS (see Appendix K) put forward by WG2, but has decided to postpone action on this issue. SG9 decided to hold a meeting during 8-10 October 1990 with NACISA, national experts, and SG9 experts in attendance to formulate a method of work and joint recommendations for technical and administrative assessments on naming and addressing, and NATO as a registration authority [TSGCEE 1990].

3.3 MMHS(88)

Revised working drafts of the MMHS(88) rationale, base standard, and two interoperability profiles have been produced. The current work is not yet stable (see Appendix K). MMHS(84) gateways, directories, protocol implementation conformance statements (PICS), and management requirements still need to be considered. The June 1990 meeting of the AHWG on MMHS (in the US) addressed MMHS profiles.

3.4 FTAM

WG2 scheduled an initial focus meeting on FTAM for June 1990. The goals were: a statement on the current status of FTAM (including profiles and products); a requirements document outlining requirements for file transfer; determination of base standard and profile enhancements; and a work plan. WG2 plans to maintain close liaison with NACISA, particularly on the development of FTAM profiles, as NACISA has undertaken work in this area. NACISA is attempting to meet a requirement identified by the U.K. to transfer large unstructured files. Civilian profiles lack security features to support this requirement. NACISA planned to complete an FTAM profile for use over the STAMINA transport profile by September 1990.

3.5 Liaison with Other Groups

WG2 has taken the position that it is premature to consider firm profile structures (WG1 FP Guidelines) at this time. The AHWG on MMHS is attempting to influence civil profile efforts, EWOS in particular, that have not adopted TR 10000, on which the WG1 draft Guidelines are based. WG2 is concerned about the deviation of the Quadrilateral Technical Interface Design Plan (QTIDP) project from the MMHS profile, the possible costs associated with altering implementations based on the QTIDP work to be conformant with the MMHS profile, and the potential interoperability problems between systems implementing different profiles.

3.6 Work Plan

WG2 developed a 12-month work plan for the period February 1990 to February 1991. This plan addresses progress of MMHS and support for ratification of the Session, Presentation, and ASN.1 STANAGs. In addition it identifies: monitoring the status of conformance testing, upper layer security, directories, upper layer management, recommendations on NATO registration issues, and *NATO C3 Architecture;* providing a response to WG1 on Functional Profile Guidelines; developing well-defined requirements for Upper Layer military extensions; and developing a WG2 way forward and program of work for real-time requirements and FTAM. A summary of the elements of this plan is provided in Table I-3 (the topics are alphabetical) [WG/2 1990a].

Table I-3. Work Plan and Activities on Upper-Layer STANAGs by WG2

(1)	Abstract Syntax Notations. Develop STANAGs covering the use of abstract syntax notations (e.g., ASN.1) and their encoding rules. Ratification of STANAGs without military extensions has been recommended to SG9. WG2 will attempt to identify requirements for military extensions. Areas of analysis have been the use of ASN.1 versus NATO Message Text Formatting System (FORMETS), encryption, and compressed encodings.
(2)	Application Layer STANAG Format. Develop a STANAG format to deal with Application Layer service and protocol specifications; this format (completed in March 1988) will form the basis for the development of separate service/protocol STANAGs such as for ACSE, FTAM, MHS, and Remote Data Access (RDA). This format will accommodate functional profiles. Functional profiles for an application will be ratified separately and included as annexes to the base STANAG for that application.
(3)	Conformance Testing. Establish a framework and methodology for testing the conformance of protocol implementations of a particular standard. Specify test sequences to be used. A proposal by Canada in March 1989 was accepted by SG9 and is awaiting a TSGCE decision on the allocation of funds and resources. The initial step would be a team of two or three persons developing detailed recommendations regarding the establishment of a permanent NATO testing organization, its structure, responsibilities, and relationship to other NATO bodies, agencies, and member Nations.
(4)	Connectionless-Mode Data Transfer. Adopt or develop standards to support connectionless-mode service at both upper and lower layers of the reference model. International standards for the upper layers (e.g., ISO 9548, ISO 8326/AD1, ISO 8822/AD1) are now stable. No schedule for WG2 in this area has been set.
(5)	Database Requirements. Determine military requirements for database management systems (DBMSs) and the potential applicability of ISO standards (from ISO SC21/WG3, such as NDL, SQL, SQL2, IRDS, and RDA; and from the activity of ISO SC21/WG1 on Distributed Application Processing and Transaction Processing). Possibly develop a new STANAG dealing with database requirements. An issue is the area of responsibility vis-a-vis ADSIA with respect to NATO information architecture. No activity other than an STC presentation in March 1989 on database replication.
(6)	Directories. Determine applicability of joint ISO/CCITT Directory standards to the NATO communication systems environment. Given need for such standards, develop an Application Layer STANAG for Directory services. An ad hoc meeting was held in June 1988 to assess the impact of Directory standards on military communications networks. Further discussion is required but not scheduled.
(7)	File Transfer. Add FTAM, with possible enhancement or modification, to the set of Application Layer STANAGs; determine what military applications FTAM might serve and how it might be adapted to, and used in, a military environment; and specify how required military features, such as security and quality of service, will be incorporated into FTAM for military use. An initial ad hoc meeting was held in June 1990. The results will be discussed at the October 1990 WG2 plenary meeting.
(8)	Formal Description Techniques. Establish a standard within NATO for use of FDTs to describe protocol and service specifications and test sequences. Several different techniques are currently used in the civilian area [SDL by CCITT, ESTELLE and LOTOS by ISO, and Tree and Tabular Combined Notation (TTCN) for test sequences in ISO and CCITT]. A requirement exists for some uniformity in both FDTs and the automated tools to support them. No activity to date.
(9)	Graphics. Determine the need for graphics within the NATO context and the relevance of ISO standards such as GKS and PHIGS or standards such as Videotex and CCITT T.73 (mixed mode); determine the need for including such standards into appropriate segments of Application and Presentation Layer STANAGs. No activity to date.

Table I-3. (Continued)

(10) MMHS. Add MOTIS service and protocol specifications and CCITT X.400 MHS-series recommendations, or parts thereof, with possible enhancement or modification; determine what military applications electronic mail might serve and how it might be used in a military environment; and specify how military features, such as security and quality of service, will be incorporated into MOTIS/MHS. See Appendix K for details of MMHS work areas by WG2.
(11) Multipeer Data Transmission. Determine military requirements for MPDT and the potential modification or creation of protocols for this task. Intermittent activity, but no resolution for further action. ISO initiated a project on this topic but suspended it due to lack of support. This pan-layer issue may eventually dictate changes to upper layer STANAGs.
(12) Naming and Addressing. Define a universal scheme for the naming and addressing of layer entities, with particular emphasis on the Application Layer. Such a scheme is necessary for interoperability of application entities that are attached to different subnetworks and may be mobile (i.e., may temporarily detach from and reattach to different subnetwork points of attachment). Examine the need for a registration authority within NATO to ensure globally unique names and addresses. WG2 has made specific recommendations (see Appendix K) to SG9 that NATO become an authority for Application Layer registration.
(13) NATO C3 Architecture. Monitor the direction and possible impact of activity in this area. Receive informal briefings. Maintain liaison with NACISA.
(14) Presentation Layer STANAGs. Develop STANAGs to encompass the OSI Presentation Payer services and protocol specifications (ASN.1 is being addressed as a separate STANAG). Ratification of STANAGs 4256 and 4266 without military extensions has been recommended to SG9. The WG2 questionnaire did not identify requirements for military extensions in the short term.
(15) Quality of Service. Determine special military requirements for quality of service; these could be general (e.g., performance requirements) or layer specific. Monitor work by the AHWG on OSI Management. This is a pan-layer issue that may dictate changes to upper layer STANAGs.
(16) Real-Time Performance. Determine special military requirements. No activity other than a presentation in October 1989.
(17) Session Layer STANAGs. Develop STANAGs that encompass the OSI Session Layer service and protocol. Ratification of STANAGs 4255 and 4265 without military extensions has been recommended to SG9. The WG2 questionnaire did not identify requirements for military extensions in the short term.
(18) Upper Layer Architecture. Determine functionality required for NATO systems with respect to Upper Layer Architecture. This activity is designed to ensure maximum uniformity between different OSI application service elements (e.g., FTAM, MHS). No activity other than one report.
(19) Upper Layer Management. Determine functionality required for NATO systems. No activity to date. A report on the U.S. Defense Message System management is planned.
(20) User Requirement Definition. Conduct a questionnaire to survey user requirements for Session and Presentation Layer deficiencies identified in the September 1988 Canadian analysis. Questionnaire was revised and circulated to Nations in May 1989. No requirements for specific changes in upper layers were identified. A recommendation to pursue FTAM was noted (see above).
(21) Virtual Terminal. Consider the potential use of civil Virtual Terminal work in a military context. No activity to date.

Source: *NATO SG9 WG2 18-Month Work Plan*, TSGCE SG9 WG2, May 1990, NATO UNCLASSIFIED.

4. NUNN INITIATIVES AND WORK PLAN OF WG3

An Ad Hoc Group on Nunn Initiatives was formed by TSGCE SG9 in March 1988 to progress three projects as multinational cooperative efforts. In part, these proposals were aimed to satisfy a request from ADSIA to TSGCE to investigate the feasibility of a transmission-media-independent data link architecture; such an architecture and the associated technical standards are needed to support stated requirements of the Air Command and Control System (ACCS). The three original proposals were to:

- Develop, test, and implement techniques for Communications System/Network Interoperability (CSNI)
- Develop an architecture for future data links based on the NATO Reference Model
- Produce draft STANAGs for the products produced in the other two projects.

NATO funds for the last two proposals have not been found.[3]

4.1 WG3 on Communications System/Network Interoperability (CSNI)

WG3 was formed in October 1989 to develop an MOU under a Nunn Initiative for CSNI. Canada, France, and the United States have signed the formal Statement of Intent for participation; the U.K., NL, and STC have also expressed interest in participating. WG3 tasking will end with a completed MOU among the participating nations, but the project itself will take about 3 years. The emphasis of this 3-year effort is not on developing standards but rather to demonstrate the operational utility of internetworking using enhanced OSI profiles with military features. While completion of the MOU was planned for December 1990, the Chairman of SG9 has suggested that WG3 be kept as an AHWG within SG9 [WG/3 1990].

The CSNI project plans a demonstration in 1993 for linking subnetworks of countries across long haul multimedia supporting multiple modes (voice, data, images). According to the January 1990 draft MOU [ADSIA 1986], WG3 will (1) ensure that the work will be closely related to the recommendations, standards, and draft STANAGs of all groups under SG9; (2) provide both feedback into the STANAG development process and practical experience on the implementation of OSI protocols on military bearer systems; (3) provide reports on the demonstration results and performance to SG9; and (4) based on demonstration results, recommend to SG9 the adoption of promising system concepts for different operational applications. An outline of the work areas being considered for the CSNI statement of work is given in Table I-4.

4.2 Media-Independent Data Link Architecture (MIDLA)

MIDLA was suggested to TSGCE by ADSIA in 1986 [MIDLA 1990]. During the period 1987-1989, the Nations attempted to identify Nunn Initiative funding for MIDLA, but these efforts were unsuccessful. At the October 1989 SG9 plenary meeting [TSGCEEG 1989], the Nations agreed that development of a data link architecture based on the OSI Reference Model to replace antiquated data links was extremely important. However, it was also agreed that resources were not available within SG9 to address the breadth, complexity, and technical aspects of that subject. SG9 agreed to send a letter to TSGCE stating the importance and magnitude of this project. In addition, the Nations were asked to assess again the availability of resources relative to the MIDLA project.

3 U.S. DoD support for the second and third items was not provided, apparently due to lack of funds.

Table I-4. Proposed Work Areas for CSNI in WG3

1. System Concepts and Testing
    a. System demonstration architecture
    b. Testing program
2. Applications and Services
    a. Database exchange
    b. Security
    c. Voice
    d. Messaging
3. Multinetwork Management and Protocols
    a. Multimedia routing
    b. Enhanced OSI protocols
4. Communications Media and Systems
    a. Long haul HF
    b. Satellite communications (SATCOM) SHF
    c. SATCOM UHF
    d. MIDS and X.25
    e. Internet
    f. VHF
    g. UHF LOS.

Source: *Draft Proposed Terms of Reference for WG3*, TSGCE SG9 WG3, 22 January 1990, NATO UNCLASSIFIED.

Some bilateral work between France and the United Kingdom is being discussed regarding future data link architectures. Further, ADSIA has received an STC study, *An Architecture Based on OSI Principles for NATO Tactical Data Links* [SHAPE 1989], and has indicated to TSGCE SG9 that no further work on behalf of ADSIA is required for MIDLA [MIDLA 1990]. However, tactical data link architecture is being addressed by the TSGCE AHWG on Restructuring as a potential area of work. SG9 has indicated that if the SG9 terms of reference are amended to include tactical links, guidance from the TSGCE would be required on providing necessary resources [WG3/1990; TSGCEE 1990b].

5. STATUS OF ACTIVITIES AND PLANS FOR DEVELOPING NETWORK MANAGEMENT STANDARDS

The lead for NATO initiatives on network management is the AHWG-OM, which addresses such pan-layer areas as fault management (detection, isolation, and correction of abnormal operation); configuration management (exercise control over identities and collect data from and provide data to managed objects in order to assist in providing continuous operation of interconnection services); security management (enable the management of the information necessary for providing security services); accounting management (enable charges to be established, and costs to be identified, for the use of managed objects); and performance management (evaluate the behavior of managed objects and the effectiveness of communication activities). Specifically, the AHWG-OM was established to:

- Define the requirements for management in a military OSI environment.
- Investigate the influence of the military features (see Appendix K) on the OSI management standards under development by ISO. The AHWG-OM has determined that the eight military features will affect, to varying degrees, all management areas.
- Influence ISO, and other standards bodies as appropriate, to adopt any additional military features identified.

- Develop any additional military management standards for the requirements not met by ISO.
- Assist in the coordination of management work within NATO and provide support for OSI management to SG9 and its working and ad hoc groups.

The work of the AHWG-OM has been focused on influencing ISO work; in addition, work has begun on a draft STANAG covering OSI management. Many members of the AHWG-OM are also members of ISO committees, and the AHWG-OM believes its work is recognized by ISO in SC21/WG4 as a major contribution of the development of standards [TSGCEE 1990c].

Many of the ISO network standards have been reorganized and now appear to have a stable framework in ISO. A new set of functions has been developed, and the model of management information has been significantly modified. The Common Management Information Service (CMIS) and Protocol (CMIP) are now International Standards (ISO 9595 and 9596).

The AHWG-OM has noted that little military influence has yet been brought to bear on Security Management, for which work is progressing very slowly in ISO. The responses to a requirements questionnaire distributed in June 1989 indicated that almost all network management practices were manual and procedurally oriented and were not relevant to what ISO is trying to standardize in Network Management. However, the results of the questionnaire confirmed the earlier military analysis document in the Working Document *NATO Requirements for Open Systems Management* (an evolving record/base document of the AHWG on OSI Management results) [TSGCEE 1988]. Enhancements to this document--specifically in Section 7, "Military Features and Their Impact on OSI Management"--arising from the questionnaire were adding the needs (1) for a broadcast facility, (2) for a capability to apply management in real time, (3) to define and work across management domains, (4) to define access control mechanisms for management information, and (5) to provide for survivability of management information (replication mechanisms). Requirements for performance management, event reporting, and management negotiation were dropped [Gutman 1990].

(U) In the February 1990 AHWG-OM meeting a formal contribution, addressed from individual nations to ISO, was drafted requesting adoption of Quality of Service (QoS) as a new work item by SC21/WG1, in response to Question Q62 on QoS. If QoS is accepted, the AHWG-OM will need to concentrate on the management-specific aspects of QoS, especially notifications.

(U) The AHWG-OM has a prioritized 21-month work plan [TSGCEE 1990c] from June 1990 through February 1992. Work on military features, broadcast, and the out-of-band Telecommunication Management Network (TMN) for ISDN was conducted at the June 1990 meeting. The remaining 1990 meetings will emphasize Quality of Service and Parts 4 (Management) and 5 (Military Features) of Edition 2 of STANAG 4250, as well as a three-volume *Management Guide*[4] to provide guidelines on the definition of NATO-managed objects. For QoS, an input paper will be developed and provided to the Nations for national input to ISO. Drafts of Part 4 to STANAG 4250 and Volume 1, *Introduction and Overview*, of the *Management Guide* was developed and distributed to other working groups in June 1990. Volume 2, is *Applying OSI Management*, and Volume 3, *Product Procurement and Considerations*, of the *Management Guide*. Updates of the Working Document will continue, with emphasis on changes made to Section 7.

6. AHWG ON ISDN

An AHWG on ISDN was formed by TSGCE SG9 in 1989 to review the status of ISDN and the applicability of these standards to NATO. The terms of reference are shown in Table I-5. An overview of the eight military features was adopted at the April 1990 meeting. The results are given in Table I-6 (note that the suitability of the ISDN protocols for use in the tactical domain was agreed to be outside the scope of the meeting) [AHWG-ISDN 1990].

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4 The full title of the *Management Guide* is *NATO Systems Guidelines for the Use of OSI Management*.

Table I-5. Initial Approach to Military Features for ISDN

(1)	Identify the ISDN domains to be standardized to assist the development of consistent ISDN standards within NATO countries and, in addition, to fulfill interoperability requirements and facilitate the development of a NATO Communications Subsystem.
(2)	Identify ISDN civil standards applicable to the systems involved in a NATO Communications Subsystem.
(3)	Review the capability of ISDN to support relevant military features, interworking requirements from tactical users/networks, and other NATO user service requirements.
(4)	Consider specifying enhancements to ISDN civil standards to meet a minimum military requirement.
(5)	Determine the impact of ISDN on the NTIS defined by SG9 in accordance with the NATO Reference Model, for example, the NTIS on network management and security.
(6)	Submit technical papers to SG9 for candidate profiles and/or STANAGs.
(7)	Submit a report to SG9 at each meeting.

Source: *Terms of Reference for TSGCE SG9 AHWG on ISDN,* NATO UNCLASSIFIED.

The AHWG on ISDN is discussing the ISDN Reference Model and has considered papers from France (based on the CCITT Reference Model and the *NATO C3 Architecture*), ETSI, and ECMA. These models describe network-to-network interworking, including CCITT No. 7 and QSIG (an extension of Q.931) protocols.

Discussion of essential bearer services for ISDNs used for NATO communications resulted in a two-page recommendation for the Network Bearer Services [viz., 64-kbps circuit switched (CS) unrestricted as in I.231.1, CS speech as in I.231.2, CS 3.1 kHz audio as in I.231.3, CS access to packet switching node as in I.231.1, B-channel packet switched access as in I.232.1, and D-channel packet switched access on the Basic Rate Interface as in I.232.1] and the Terminal Bearer Services. Further study has been recommended for Frame Relay (I.122), Frame Switching (I.122), user-to-user signalling (I.232.3), 7 kHz audio, 2x64 kbps unrestricted, H0--384 kbps unrestricted, H11--1536 kbps unrestricted, and H12--1920 kbps unrestricted.

Table I-6. Military Features for ISDN

(1) Mobile Hosts and Multihomed Systems. A number of scenarios are being discussed, some outside the ISDN domain (e.g., in the tactical area) and some within the strategic ISDN domain (e.g., as user moving from one PABX to another). Only strategic ISDN domain issues are currently being addressed in the AHWG on ISDN. It was agreed that ISDN Suspend/Resume procedures for moving during a call were not applicable to mobile hosts. Some form of slow mobility is required where a user may, for example, move between extensions on the same access switch or even to a different access switch and still maintain the same user identify. This would require a type of registration and cancellation procedure where a user takes the user identity around a fixed network. Specific NATO procedures may be required to realize this feature--further study is required. Procedures associated with the cellular radio service are issues mainly applicable to the tactical domain.

(2) Multi-Endpoint Connections. Information needs to be multicast (or broadcast) to several destinations. A central issue is whether a unidirectional service was required for this feature:

(a) If the requirement were defined in terms of a conference call (bidirectional), then commercial products are expected to be available.

(b) If broadcast facilities were provided at the Application Layer using packet procedures, no specific NATO procedures are required.

(c) If broadcasting were required on all bearer services (e.g., voice and data), then the AHWG on ISDN should wait for CCITT/ETSI to define this feature.

It was generally agreed that the multi-endpoint feature is for data application rather than voice; further study is required on the requirement for voice.

(3) Internetworking. The *NATO C3 Architecture* (Volume 4, *Communications Subsystem*) allows both the "T" reference point and the K, M, and N reference points as possibilities for internetworking. If the "T" reference point were chosen, then a number of enhancements would be required for NATO, such as satellite and routing indicators.

(4) Network and System Management. CCITT is defining a network management structure in both the user-network area (Q.940) and within the network. This work is at the architectural level and has not resulted in a definition of detailed procedures. Of particular interest to SG9 are the management functions of Section 3 of Q.940 for fault, configuration, accounting, performance, and security management--all aligned with OSI management functions. In addition, management reference models have been defined.

(5) Security. Key issues are the applicability of NOSA to ISDN (for data services), the impact of ISDN on NOSA (e.g., security of voice services, protection of signalling channels), and the definition of new security features using ISDN capabilities (e.g., common channel signalling). The first two issues are for the AHWG on Security. The AHWG on ISDN will propose ISDN security features relevant to the third issue (e.g., supplementary services) for approval by security experts of SG9.

(6) Robustness and Quality of Service. The only possible special NATO requirement identified is the QoS parameter, should the ISDN network performance figures given in I.350 not prove to be adequate for military applications.

(7) Precedence and Preemption. This feature is already being addressed (service definition and information).

(8) Real-Time and Tactical Communications. No special real-time requirements are foreseen for ISDN. Note that the discussion was limited to interworking with a tactical network and to the concept of a strategic ISDN activity either as a transit network or to gain access to an ISDN user.

Note: The suitability of the ISDN protocols for use in the tactical domain was agreed to be outside the scope of the assessment leading to these requirements.

Source: *Report of the 2nd Ad Hoc Meeting on ISDN, Paris, 24-26 April 1990*, TSGCE SG9 AHWG on ISDN, May 1990, NATO UNCLASSIFIED.

One proposal (submitted by the U.S.) suggests the following as the basis for a draft STANAG on ISDN for packet mode services [AHWG-ISDN 1990a]:

- Networks shall support a packet-switching capacity in conformance with the 1988 CCITT recommendation on packet-switched data, X.31/I.462, *Support of Packet Mode Terminal Equipment by an ISDN.* At the user interface for the Basic Rate Interface, both B channel and D channel packet switching will be supported. At the Primary Rate Interface, B channel packet switching will be supported. Terminals that support X.25-based packet switching will also conform to X.31.
- Conditional notification shall be supported on switched access connections. On permanent virtual circuits, the option of "no notification" shall be available.

The issues identified in Table I-7 have been recommended to be the focus of future efforts in the AHWG on ISDN (but have not been adopted) [AHWG-ISDN 1990b].

Table I-7. Initial Draft Proposed Work Plan and Activities on ISDN

(1)	Work on progressing the layer integration of the OSI Transport Service with the ISDN Digital Access Signalling System
(2)	Develop and provide directory capabilities for resource identification and selection, to include an Application Title Directory and a Network Address Directory, based on ISO 9594 (CCITT X.500)
(3)	Add naming and addressing issues with respect to ISDN to the SG9 working group pursuing these issues
(4)	Adopt the CCITT Common Channel Signalling System No. 7 (SS7) internationally
(5)	Study further tactical communications support by ISDN, with special attention to interconnection with digital radio and cellular networks and to the requirements for maintaining radio silence (e.g., unacknowledged data transfer)
(6)	Address (in the appropriate SG9 working groups) security and system management services as they pertain to ISDN and the coordination of ISDN and OSI Registration Authority issues
(7)	Accelerate the cooperation between ISDN and OSI standardization and planning efforts
(8)	Address the capabilities of B-ISDN to meet the minimum military requirement and consider viewing B-ISDN as the focus for future telecommunications services
(9)	Resolve the issue of interconnecting TCS "black boxes" to ISDN (TCS interfacing to ISDN needs further study)
(10)	Pursue the resolution of ISDN and OSI harmonization in NATO through direct involvement in established working groups within each individual nation, making these groups aware of NATO needs to promote military requirements.

Source: *ISDN/OSI Integration: Issues, Trends, and Recommendations,* Contribution from Canada to the Initial Meeting of the AHWG on ISDN, January 1990, NATO UNCLASSIFIED.

7. AHWG ON SECURITY

The AHWG on Security has developed three major references for use in SG9: *NATO OSI Security Architecture (NOSA)* [NOSA 1988], *Security Architecture for NATO Information Systems Interconnection (SANISI)* [SANISI 1989], and the *NATO Network Security Information Classification Guide* [NATO 1989a]. NOSA was developed to give guidance to contractors and procurement managers on the preferred placement of security services within OSI-conformant systems. SANISI provides detailed rationale on the placement of security services and mechanisms within the OSI Reference Model. A key element of SANISI is the requirement in Layer 3 for a Trusted Communications Sublayer (TCS). NOSA and SANISI do not identify a requirement for security protocols for Layer 4.

[5]Two security protocols (SP3 and SP4) have been introduced into ANSI from the U.S. Secure Data Network System (SDNS) [TSGCEE 1989]. SP4 has been accepted as a work item in SC6/WG4 in ISO, and SP3 is expected to be accepted when some additional work on SP3 is completed in 1990. SP3 is the protocol most closely aligned with TCS. Since the distribution of NOSA and SANISI, the AHWG on Security has been addressing questions regarding the security protocols that have been introduced for Layer 3, including SP3, Northern Telecom's SPX, and the U.K.'s End-to-End Security Protocol (EESP). SP3 was judged as equivalent to the end-to-end encryption portion of the TCS. SPX adds connection-oriented service to SP3. The EESP adds CO services to SP3 and includes integrity and traffic padding.[6] The AHWG on Security anticipates that SG9 should be able to arrive at a Layer 3 protocol that will satisfy NATO military requirements [AHWG-S 1990a].

Discussion of SANISI has included proposed annexes on application and implementation aspects of the TCS and the Denial of Service definition. Agreement has been reached that once an event object is defined, the recovery mechanisms are the same whether the cause was malicious or accidental and so is a management issue. A review is to be conducted of the SANISI annexes to determine if these can be downgraded to NATO UNCLASSIFIED and be permitted to be used as technical input to ISO.

The AHWG on Security is reviewing and maturing concepts of an ISDN security architecture. The AHWG has noted that the *NATO C3 Architecture* underlines the importance of becoming aware of the security problems associated with an architecture that combines circuit switching with packet switching handling real-time voice and high-bandwidth data. A paper has been developed on security management; it will be condensed and included as Annex D in the NOSA document.

The AHWG has expressed strong support for the WG3 program to demonstrate the proof of concept of the security protocols and architecture. The AHWG on Security has noted concerns that have been expressed that SDNS SP4 is not a suitable candidate from a NOSA point of view, as NOSA does not identify a requirement for security services in the Transport Layer. A recommendation was drafted that WG3 consider the concept of a TCS as in NOSA and SANISI.

The AHWG on Security held a meeting of security experts in June 1990 to discuss the TCS service definition and protocol specification. Progress was made on providing the additional technical work required for a detailed design specification for the TCS. This specification will be provided to the SG9 WGs for consideration and, in the case of WG3, possible implementation.

The current 18-month work plan, shown in Table I-8, has been focused to allow the AHWG to concentrate on the aspects of the security problem most visible in ISO, namely the Layer 3/Layer 4 security protocol. The AHWG believes that it is in this area where it has the greatest expertise and the best possibility of influencing ISO to adopt a standard suitable for NATO. The goal would be host protection, in addition to link protection. The next step will be application protection.

8. STATUS OF ACTIVITIES AND PLANS FOR DEVELOPING THE MILITARY MESSAGE HANDLING SYSTEM (MMHS) FOR NATO

During the last 3 years, an AHWG on MMHS, reporting to TSGCE SG9 WG2, has been working to have features required by the military incorporated into the MHS defined by international standards bodies. The initial proposals, based on X.400-MHS(84), for an MMHS have been accepted as an Intercept Profile by SG9; it addressed security, confidentiality, integrity, authentication, message stores with access protocols, and directory services. Most of these features have now been incorporated in CCITT X.400-MHS(88). Known as the "Blue Book," MHS(88) was ratified in November 1988.

5

6 EESP was introduced into SC21/WG1 during the May 1990 meeting in Seoul. EESP has been proposed to the JTC1 as a new work item.

Table I-8. Work Plan for AHWG on Security

(1)	Prepare glossary of terms
(2)	Consider registration authority issue
(3)	Review ISO activities on security
(4)	Analyse relation of ISDN and TCS
(5)	Review TCS Service and Protocol documents
(6)	Prepare TCS issues document for meeting of experts
(7)	Provide comments on NATO C3 Architecture
(8)	Edit and review classification of NOSA and SANISI texts
(9)	Update document on Security Management managed objects
(10)	Review upper layer security issues
(11)	Develop rationale for TCS placement

Source: *Agenda for 10-13 September 1990 Meeting of AHWG on Security*, 24 May 1990, NATO UNCLASSIFIED.

MMHS will be addressed in a separate Application Layer standard, STANAG 4257; the first working draft of this STANAG was provided to WG2 in February 1990. STANAG 4257 will incorporate four elements that are being developed simultaneously by the AHWG on MMHS: Base Standard [AHWG-MMHS 1990], Rationale [AHWG-MMHS 1990a], an Alpha Profile, and a Beta Profile. The Alpha profile is intended to address strategic and tactical applications where bandwidth limitations are not severe, and the Beta Profile is intended to address tactical applications where bandwidth is severely limited. For the Beta profile, the AHWG on MMHS assumes that bandwidth will be conserved by eliminating all but the most vital services of MHS. These profiles are being written as a "delta" or change to the MHS profile being developed by the European Workshop for Open Systems (EWOS) [EWOS 1990a]. Each MMHS profile will be included in STANAG 4257 as a separately ratifiable annex [WG/1 1990c].

The AHWG-MMHS work has been separated into two sets of functional groups. The first set consist of military messaging services, notification, security, redirection, distribution lists, conversion, ACP 127, and MMHS(84) gateways. The second set will provide directories, message store, physical delivery, management, routing, local services, and PICS. The first draft of the MMHS(88) STANAG [AHWG-MMHS 1990] released in February 1990 addresses the first set of functional groups.

One of the key issues for MMHS is the need for NATO-wide consistency and uniqueness of names and addresses to be in conformance with international standards. WG2 made the following recommendations developed by the AHWG-MMHS to SG9 in May 1990 [WG/2 1990b]:

- Register NATO as a country name with ISO. If this is not acceptable to ISO/CCITT, then NATO should be registered as an Administrative Management Domain within one country (e.g., Belgium).
- Obtain a number for NATO as an Identified Organization in the object identifier structure detailed in ISO 9834.
- Establish a NATO registration authority to register the addresses of end users within NATO management domains (both domain names and the domain-specific part), to register Application process names and Presentation addresses, and also to manage the allocation of numerical subscripts to objects.

In June 1990 the AHWG on MMHS reviewed these recommendations in light of additional information provided by STC. MMHS has now withdrawn the above recommendations and plans to study the requirements and alternatives in detail.

The *Intercept Profile for MMHS*, based on MHS(84), has been amended (Issue 2) to include full support for ACP 127 [MMHS 1990]. It was completed in February 1990 and is ready for distribution by SG9. Issue 2 has a new annex (Annex C) on implementation options for the military header extensions. Issue 1 of the profile was accepted as an intercept strategy for the 1989 (Fifth) edition of the *NTIS Transition Strategy* [Purton 1987]; however, depending on choices of interoperability parameters, MMHS implementations based on MHS(88) may not be backwards compatible with MHS(84) implementations.

One area of MMHS not addressed by MHS(88) is support for trusted functionality. Such support may be covered by standards developed by the SDNS security protocols SP3 and SP4 to carry out services associated with trusted functionality. The May 1989 meeting of the AHWG-MMHS was devoted to security and succeeded in developing two functional groups of security services. One of these does not require use of asymmetric encipherment mechanisms, but precludes direct support of nonrepudiation services. These have both been accepted by EWOS. The AHWG-MMHS is seeking guidance from the AHWG on Security to identify suitable encipherment mechanisms to support these services [WG/2 1989]. The AHWG on Security confirms the need for asymmetric cryptographic mechanisms and indicates that such mechanisms must be offered by the Nations for consideration and approval by the appropriate NATO authorities [AHWG-S 1990a].

A number of MMHS-related issues are identified in the WG2 12-month work plan. These include editing and publishing the MMHS(88) Base Standard, Alpha Profile, Beta Profile, Rationale, overview statement, and statements of requirements for registration, security, management, and directory; specifying conformance requirements (postponed until 1991); specifying implementation guidelines for MMHS and for Directory support of messaging domains including MMHS and ACP (commencing June 1990); defining military extensions and methods for distribution lists; developing an evolutionary strategy; developing an MMHS(88) profile; developing MMHS management issues and requirements to be forwarded to AHWG on OSI Management (February 1991); defining the role of a Message Store in support of mobile hosts, plus extensions of civilian services to access the Message Store (June 1990); defining MMHS naming conventions for upper layer OSI information objects such as application processes, abstract systems, transfer syntaxes, and application contexts; and developing a security model, security profile, and T-profile.

Table I-9 provides a statement and status summary of the work areas for MMHS being addressed in the 12-month work plan of the AHWG on MMHS for the period March 1990 to February 1991 (order of entries is alphabetical) [AHWG-MMHS 1990b].

Table I-9. Work Plan and Activities on MMHS

(1) Applications. Develop a guide to applications supported by MMHS. No activity to date.

(2) Base STANAG (MMHS(88)). Develop an MMHS STANAG based on CCITT X.400-1988, with extensions to meet military requirements. Activity commenced in January 1989 and is expected to be released to the Nations for comment after the June 1991 AHWG-MMHS meeting. The complete STANAG will be written as a "delta" document to the EWOS MHS profile. This means that instead of specifying the complete standard, it will only specify the changes to the EWOS document. It will consist of a Base Standard (which describes all the Elements of Service, rationale, default values, etc.), an Alpha profile for use in normal circumstances, and a Beta profile (which will exclude all but the essential services for message passing) for use in an environment of restricted bandwidth.

Table I-9. (Continued)

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(3) Conformance Requirements. Specify conformance requirements and testing procedures for MMHS products and implementation. Postponed pending completion of the first draft MMHS base STANAG.

(4) Directory Guidelines. Specify implementation guidelines for Directory support of messaging domains, including MMHS and ACP 127. Begun June 1990.

(5) Distribution Lists. Define military extensions and methods for Distribution Lists. Main issues have been identified and documented in the working drafts of the base standard and profile.

(6) Evolution Strategy. Develop a full plan for specifying time frames for interconnecting MMHS, ACP 127, and civilian MHS domains and for including MMHS(88) features. Commenced January 1989, but no activity since.

(7) Implementation Guidelines. Develop implementation guidelines for MMHS based on MMHS operating procedures; include gateway issues. Discussion but no report to date. (Target for draft document was February 1990.)

(8) Local Services. Develop guidelines for common local services. Started work in June 1990; draft was planned for September 1990.

(9) Management Issues. Develop MMHS requirements to be forwarded to the AHWG-OM. Started work in June 1990; draft planned for September 1990. Target publication date was February 1991.

(10) Mapping to Eight Military Features. Map the MMHS requirements to the eight military features. One contribution has been made; further work is pending resolution of the features themselves.

(11) Message Store. Define role of the Message Store in support of mobile hosts, plus extensions of civilian services to access the Message Store. Started work in June 1990; draft planned for September 1990.

(12) MMHS Intercept Profile ('84). Maintain an interoperability profile based on MHS(84) for use until the MMHS STANAG is mature. Version 2 was completed in February 1990 and provided to SG9 for publication It is expected to appear in the next (Sixth) edition of the *NTIS Transition Strategy.*

(13) Naming and Registration. Define MMHS naming conventions for upper layer OSI information objects such as application processes, abstract syntaxes, transfer syntaxes, and application contexts. Establish registration authority (or authorities) and define registration procedures for names requiring registration. Deferred to SG9 for direction; recommendations forwarded by WG2 to SG9.

(14) Physical Delivery. Scope and produce guidelines for physical delivery. No activity to date.

(15) Routing. Define algorithms and constraints. Started work in June 1990; draft planned for September 1990.

(16) Security Model. Define a general architectural model for MMHS security services and mechanisms. List of outstanding issues created. Security parts of profile identified.

(17) Security Profile. Develop an MMHS security profile based on MHS(88) security services, plus additional algorithms, support systems, and procedures. Document underdevelopment based on EWOS profile A/3311 plus additional issues. Draft base STANAG [AHWG-MMHS 1990] and profile produced. Guidance of Nations sought on acceptability of security mechanisms.

(18) T-Profile. Define a Transport Layer implementation profile for MMHS. Deferred to WG2.

(19) Testing Issues. Identify testing requirements and develop conformance and interoperability tests. Deferred to SG9 for direction.

(20) Transition Guidelines. Define transition strategy from intercept interoperability profile to final MMHS STANAG and functional profiles. Draft MMHS over paper produced that includes migration of ACP 127 and MHS to MMHS.

(21) User Requirements. Define user requirements to be met by MMHS functional and interoperability profiles. National inputs received from questionnaire in January 1989. No other activity planned.

Source: *MMHS AHWG Input to NATO TSCCE SG9 WG2--12-Month Work Plan,* TSGCE SG9 WG2 AHWG on MMHS, February 1990, NATO UNCLASSIFIED.

STATUS OF NATO OSI STANAGs[1]

1. INTRODUCTION

This appendix summarizes the status of NATO OSI STANAGs. Table J-1 identifies the STANAGs being developed that will specify ISO standards and applicable military options and extensions, if any. Work has begun on all these STANAGs, but only the NATO Reference Model, STANAG 4250, has been ratified. Originally, TSGCE SG9 planned to issue a single STANAG for all services and a second STANAG for all protocols at each layer, giving a total of 14 STANAGs in addition to STANAG 4250, the NATO Reference Model. In October 1987, TSGCE SG9 agreed to work at the Application Layer for single STANAGs for each Application Layer service, such as MMHS (STANAG 4257). Protocol specifications as well as service definitions would be addressed in that STANAG. This approach will require editorial changes in STANAG 4250.

Table J-1. NATO OSI Standards

OSI Layer	Service Definitions		Protocol Specifications	
	STANAG	Draft Published	STANAG	Draft Published
Reference Model	4250 Ed 1 4250 Ed 2 Prt 1	Apr 86 (Ratified) May 90 (Draft)[a]	-	-
1	4251	13 Jul 90	4261	6 Jul 90
2	4252	Jul 90	4262	Jul 90
3	4253	Jul 90	4263	Jul 90
4	4254	Jul 90	4264	Jul 90
5	4255	12 April 90	4265	12 April 90
6	4256 4258 (ASN.1)	19 Jan 90 15 Jan 90	4266 4259 (ASN.1 BER)	19 Jan 90 19 Jan 90
7	4257(MMHS)[b]	16 Feb 90	4257(MMHS)[c]	16 Feb 90

When stacks of standards, options, and interoperability parameters that involve more than one OSI layer are selected for open systems interconnection for NATO data processing and distribution systems, the agreements will be specified in documents that are to be known as functional profiles. NATO functional profiles, initially to be drafted by TSGCE SG9, will be based on the OSI STANAGs 4250-4259 and 4261-4266. To date, the functional profiles promulgated by TSGCE SG9 are contained in the *NTIS Transition Strategy* and are all based on commercial international OSI standards and the OSI STANAGs. These profiles (application, transfer, and relay) are identified in Tables 14, 15, and 16 of Section 6.3.1 and illustrated in Appendix B.

STANAG 4250, *NATO Reference Model for Open Systems Interconnection*, is being revised and the new draft developed in the May 1990 TSGCE SG9 plenary meeting was circulated to the Nations. The new STANAG will be in five parts, only the first of which is ready for ratification. The first four parts conform to the current structure of the OSI Basic Reference Model, ISO 7498:

[1] Effective date of this Appendix is July 1990.

- Part 1--*General Description*
- Part 2--*Security*
- Part 3--*Naming and Addressing*
- Part 4--*Management*
- Part 5--*Military Features.*

Two additional parts (*NATO Functional Profile Guidelines* and *Conformance Testing*) were separated from STANAG 4250 and will be drafted and ratified separately. In May 1990, SG9 agreed to reissue Edition 2 of STANAG 4250 as described above without going through a formal ratification process. Thus, STANAG 4250 has been forwarded to the TSGCE for promulgation.

During its meetings in February 1989, TSGCE SG9 WG2 addressed the impact of the eight military features on the Session and Presentation Layers, especially for security, quality of service, and multipeer data transmission. WG2 determined that for both the Session and Presentation Layers there are no military features that have been defined, that are needed in the near term, and that are not supported by the OSI standards. WG2 has therefore forwarded the draft STANAGs for the Session and Presentation Layer (STANAGs 4255, 4256, 4265, and 4266) and ASN.1 (STANAGs 4258 and 4259) to TSGCE SG9 for ratification; TSGCE SG9 decided in March 1989 to distribute these drafts to the nations to begin the ratification process. These drafts were modified by WG2 in February 1990 and provided to SG9 in May 1990. SG9 identified a number of editorial problems with the draft STANAGs, requested these be addressed by WG2, and asked for revised drafts at the December 1990 SG9 plenary meeting.

The remaining paragraphs in this section summarize the scope of the current drafts of these STANAGs. The STANAGs are discussed layer by layer beginning with Layer 1, the Physical Layer. The discussion emphasizes the portions of the STANAGs addressing deficiencies and enhancements for the military features.

2. PHYSICAL LAYER STANAGs

Draft STANAG 4251 (July 1990) identifies for the Physical Layer all eight areas for potential military enhancements and summarizes the services provided by and the deficiencies of current civil standards. All but three of the areas are identified as "not envisioned to affect the Physical Layer." The three areas in which enhancements are expected are:

- Network/system management functions. ISO 9595 (*Management Information Service Definition*) is cited for relevance, but military enhancements to those standards are left for further study (the July 1990 draft cites several parts to ISO 9595 that were dropped by ISO in 1989 when DIS 9595-2 was adopted as ISO 9595).
- Security. ISO 9595-7 (*Management Information Service Definition--Part 7: Security Management Service Definition*) is cited for relevance, but military enhancements are left for further study, to be provided as Annex B.
- Robustness and quality of service. ISO 9595-6 (*Management Information Service Definition--Part 6: Performance Management Service Definition*) is cited for relevance, but military enhancements are left for further study.

Draft STANAG 4261 (July 1990) also identifies for the Physical Layer all eight areas for military enhancements, summarizes the protocols provided by and the deficiencies of current civil standards, but leaves specific military enhancements for further study. All but three of the areas are identified as "not envisioned to affect the Physical Layer." The three areas in which enhancements are expected are the same as for STANAG 4251:

- Network/system management functions. ISO 9596 (*Management Information Protocol Specification*) is cited for relevance, but military enhancements are left for further study in Annex H (the July 1990 draft cites several parts to ISO 9596 that were dropped in 1989 by ISO when DIS 9596-2 was adopted as ISO 9596). The following statements are cited in Annex H as military "enhancements to CCITT Physical Layer protocols":

(1) Unbalanced and balanced interchange circuits for use on general telephone systems in the tactical, sustaining base, and long-haul environments monitoring circuit fault conditions shall do so as indicated in V.24.

(2) Data interchange circuits in the tactical, sustaining base, and long-haul environments monitoring circuit fault conditions shall do so as indicated in X.24.

(3) In the tactical and sustaining base environment, all unbalanced interchange circuits shall detect circuit failure and interpret a fault condition as a type 3 circuit on which the receiver or load provides a special indication as stated in V.10. This is to be implemented as a service provided by the Physical Layer management entity and sent to the fault management application entity as a system management data unit.

- Security. ISO 9595-7 (*Management Information Protocol Specification--Part 7: Security Management Protocol Specification*) is cited for relevance, but military enhancements are left for further study, to be provided as Annex B.
- Robustness and quality of service. ISO 9595-6 (*Management Information Protocol Specification-Part 6: Performance Management Protocol Specification*) is cited for relevance, but military enhancements are left for further study in Annex H.

Requirements for Mechanical Aspects (Annex D) are provided by STANAG 4261 in the areas of connectors, pin outs, cabling, and shielding and dielectric. Requirements for Functional Aspects are provided for data and control (timing and grounds are left for further study). Requirements for Electrical Aspects are provided for interchange circuits and cabling. Requirements for Procedural Aspects are provided in connection establishment (connection completion, connection maintenance, and data transfer are left for further study). Requirements for fault management, configuration management, performance management, and security management are briefly discussed under Management Aspects. Annex I will address military requirements for the X.21 "permanent" protocol and Annex J will address the tactical "K" protocol.

3. DATA LINK LAYER STANAGs

STANAG 4252 will address, as does ISO 8886 upon which it is based, both CO and CL modes of service. None of the security aspects (Annex B) have yet been identified for the Data Link Layer. STANAG 4252 identifies deficiencies only in one of the eight areas for enhancements:

- Network/system management. The definition of the Data Link Management Objects and their manipulation are not covered in the existing ISO standards, but are the subjects of on-going work and are expected to be completed in the near future. After completion it will be verified if military enhancements are requisite. Data Link Management Objects are required for DIS 10164, DIS 10165, and ISO 9595.

The current draft STANAG 4262 indicates that "no need for enhancement was identified" for all but one of the eight areas of potential military features. The remaining area is addressed as follows, without specifying the protocols needing enhancement:

- Network/system management. Enhancements are needed, but these may be provided as a result of the on-going ISO standardization work. If this is not the case, further work would be needed to provide the missing military enhancements. Note: The specification of Data Link Layer Management Objects is the subject of the work item JTC 1.06.04 in ISO.

Annex D of the current draft STANAG 4262 addresses the Balanced Link Access Procedure B (LAP B), based on ISO 7776 and provides for the CO-mode data link service used by packet level protocols (PLPs) such as CCITT X.25 PLP and ISO 8208. Annex E addresses LAP D based CCITT I.440 and I.441. Annex F addresses the Logical Link Control (LLC) and the Media Access Control (MAC) protocols, based on ISO 8802-2 (LLC), 8802-3 (CSMA/CD LAN), 8802-4 (Token Bus LAN), and 8802-5 (Token Ring LAN). The LLC, when used with the appropriate MAC data link sublayer protocol, provides CO and CL-oriented data link service in a LAN environment. Annex G addresses the data link protocol Balanced Class of Procedures (BAC) based on the HDLC standards ISO 7809, 4335, 3309, and 8885 and provides CO- and CL-mode services. Options explicitly include Exchange Identification (XID), UI frames for CL-mode data

transfer, selective reject, extended sequence numbering, test, and extended frame check sequence capability (32-bit frame check sequence).

4. NETWORK LAYER STANAGs

STANAG 4253 is based on ISO 8348 *(Network Service Definition)*, including the three addenda, and thus provides for both connection-mode and connectionless data transmission. The Security Annex is classified; as provided in the NOSA document (see Section 9.2.3.2), it addresses services such as peer entity authentication, data origin authentication, access control, connection confidentiality, connectionless confidentiality, traffic flow confidentiality, connection integrity without recovery, and connectionless integrity. STANAG 4253 addresses the areas of deficiencies of the civil standards shown in Table J-2 for providing military feature enhancements.

Table J-2. Areas of Deficiencies for STANAG 4253

(1) Multihoming. In the interest of survivability, an end system, identified by a single "logical" network address, may need to be connected at several Subnetwork Points of Attachment (SNPAs) either with more than one link into the same subnetwork or with links into several subnetworks. Routing management functions will be needed in order to determine the SNPA to be used; enhancements for routing management (if any) are for further study.

(2) Mobile Hosts. This requirement is for end systems identified by a single logical address to be able to connect to different SNPAs, although only one connection may be in use at any one time. In this case it may not be possible to determine in advance which subnetwork links will be involved in establishing connections associated with a particular subscriber address. The Network Layer addressing is extended in this STANAG to support logical network addresses that may identify more than one NSAP. Enhancements for routing management (if any) are for further study.

(3) Multiaddressing. To economize on network bandwidth and increase speed of delivery, an application that involves sending the same data to a number of destinations will require a multi-addressing service (multipeer data transmission) within the Network Layer, which provides either selective addressing or broadcast facilities. The Network Layer addressing is extended in this STANAG to support multicast addresses that may identify more than one NSAP. Enhancements for multipeer data transmission are for further study.

(4) Management. Additional management facilities may be required to support the other military enhancements. Military enhancements of the ISO Network Layer management objects are for further study.

(5) Security. The ability is required to signal the security label of each network connection and each connectionless service data unit. The security classification will remain constant throughout the life of a connection. The security label for a network connection or a connectionless service data unit may be signalled as a protection QoS parameter.

(6) Robustness. The ability to survive physical damage and denial of service attacks and to route around damaged or partitioned networks is required for military systems. Military enhancements to Network Layer management functions for robustness are for further study.

(7) Precedence and Preemption. No requirement for military enhancement has been identified beyond the priority QoS parameter defined in ISO 8348.

(8) Real-Time Communications. Enhancements for real-time communications are for further study.

Source: *Draft STANAG 4253*, July 1990, NATO UNCLASSIFIED.

Annex D to STANAG 4253 discusses the two types of addresses used in the Network Layer: (1) subnetwork addresses, which identify a point of attachment to a subnetwork (e.g., an X.25 network) and (2) network address, which is (ISO 7498-3) a name, unambiguous within the OSI environment, that is used to identify a set of NSAPs. An NSAP-address is a network address that is used to identify a single NSAP. The subnetwork address must be derivable from the network address, either directly using a field of the

network address or indirectly using table lookup/directory service functions. An NSAP may have two or more NSAP-addresses, such as where a system performs two roles (e.g., National and NATO) or where a system is multihomed. Annex D provides technical detail on:

- Addressing schemes, including the Initial Domain Part (IDP) and the Domain Specific Part (DSP) of an NSAP-address, the Authority and Format Identifier (AFI) and Initial Domain Identifier (IDI) that make up the IDP, and the four basic schemes recognized by ISO 8348/AD2.
  (1) CCITT numbering schemes for public networks--the IDI is X.121 for packet switched networks, F.69 for Telex, E.163 for circuit switched networks, or E.165 for ISDNs.
  (2) Schemes with an address allocated under a national registration authority, in which the IDI is an ISO Data Country Code (DCC) according to ISO 3166.
  (3) Schemes with an address allocated under an international registration authority, in which the IDI is an ISO International Code Designator (ICD) allocated according to ISO 6523.
  (4) Local schemes that would only be recognizable amongst a restricted network of systems.
- The NATO-ICD scheme, in which NATO, as an international authority, allocates addresses. The AFI is 46 for ICD decimal addresses and 47 for binary addresses. Currently there is one NATO addressing sub-schema defined, the scheme "X" that uses AFI=46 and NATO Format Identifier=10. This scheme is for use with decimal coded addresses using NATO domain identifiers allocated under STANAG 4214.
- Multicast addressing, which can be used in the Network Layer to identify a set of NSAPs. Multicast addresses are defined as extensions to the network addressing scheme and so can operate only between NSAPs supporting the same scheme. Multicast addressing across national boundaries is not supported by the DCC scheme.

STANAG 4263 provides for three types of CO-mode Network Layer protocols: (1) DTE-to-DTE, based on the 2nd Edition of ISO 8208 (*X.25 Packet Level Protocol for DTE*, 1990); (2) DTE-to-DCE, based on ISO 8878 (*Use of X.25 to Provide the OSI CO Network Service*) and the 2nd Edition of ISO 8208 <u>for end systems</u> and on CCITT X.25(1988), Sections 3, 4, 5, 6, 7, and Annexes A-I, <u>for subnetworks</u>; and (3) STE-STE, based on the X.75 Packet Level Protocol (Sections 3 through 5 and Annexes A through E) for the interconnection of two packet-switched data networks. These all provide the connection-oriented network service (CONS). The use of the X.25 PLP to provide the CONS over an ISO 8802 LAN is not currently addressed in STANAG 4263.

Annex B on security for STANAG 4263 has yet to be produced (as of July 1990), but will address--as provided in the NOSA document (see Section 9.2.3.2)--services such as peer entity authentication, data origin authentication, access control, connection confidentiality, connectionless confidentiality, traffic flow confidentiality, connection integrity without recovery, and connectionless integrity.

No military enhancements are specified in STANAG 4263 Annex D for the DTE-DTE CONS. The required military enhancements for DTE-DCE CONS (Annex C) are given in Table J-3.

Table J-3. Military Enhancements Identified for Annex C of STANAG 4263

(1)	Security. The use of the network service Protection Quality of Service parameter to associate a security level with a network connection is for further study.
(2)	Precedence and preemption. The priority of a network connection shall be indicated, when appropriate, by means of the network service Priority Quality of Service parameter. This parameter is mapped in this protocol to the Priority CCITT-specified DTE facility as defined in ISO 8878 DAD1. The use of this facility is optional in this STANAG, but may be enforced by specific profiles. Absence of the Priority facility from any of the packet types in which it may appear shall be interpreted as indicating the lowest defined priority level, and Priority-aware implementations shall act accordingly. The Priority facility shall be transmitted unchanged between the two network service users; however, this STANAG extends the specification of X.25(1988) in the following way: a subnetwork may inspect the Priority facility in order to record the priority of a connection and may use this information to preempt a lower priority connection under certain (subnetwork-dependent) conditions. In this case, the subnetwork shall clear the connection, with cause "DCE originated" and reason "QoS not available--transient condition," with the result that both network service users receive an N-Disconnect indication with originator "NS provider" and reason "Connection rejection--QoS not available/transient condition." Priority values are integers in the range 0 to 14, with 255 meaning "unspecified."
(3)	Multihoming. Multihoming may be achieved through the X.25 Hunt Group optional user facility, provided the SNPAs corresponding to the various "homes" can be defined as members of an X.25(1988) Hunt Group. The use of the Hunt Group facility for multihoming is transparent to the OSI network service user. Three types of Network Layer management facilities are specified in the STANAG to support the use of a Hunt Group: configuration, multihoming subscription options, and multihoming registration.

Source: *Draft STANAG 4263*, July 1990, NATO UNCLASSIFIED.

An enhancement for only one military feature is specified in Annex E for interconnecting two packet-switched networks using X.75:

- Precedence and preemption. The priority of a network service connection shall be indicated, when appropriate, by means of the network service Priority Quality of Service parameter as in Annex C. This parameter is mapped by the protocol to the X.25(1988) Priority facility. According to X.75(1988), the Priority facility is relayed unchanged as an X.25 user facility, which may be inspected and whose values are stored, but which does not affect the progress of the virtual call. This STANAG extends the specification of X.75(1988) in the following way: an STE may record the priority of a call and use this value to preempt a lower priority call under certain (implementation-dependent) conditions. In this case, the STE shall clear the call with cause "DCE originated" and reason "QoS not available--transient condition," as though the call had been cleared by one of the interconnected subnetworks according to the specifications of Annex C. Priority values are integers in the range 0 to 14, with 255 meaning "unspecified."

Annex E to STANAG 4263 defines an internet protocol (IP) for CL-mode network service and relies on the provision of an underlying CL-mode service directly from a CL-mode real subnetwork or indirectly through the operation of an appropriate Subnetwork-Dependent Convergence Function (SNDCF) or Protocol (SNDCP) over a CO-mode real subnetwork. Annex E is based on ISO 8473 (Sections 3-9 and Annexes A-C) and provides extensions for the following three military features:

- Security. A security parameter is provided in every IP Protocol Data Unit (PDU) using the Security Option. The structure of this parameter is for further study.

- Precedence and preemption. Priority is realized through selection of a parameter in the options part of the PDU header. The priority option shall be mandatory for end systems and intermediate systems conforming to this standard. Encoding of the precedence and preemption parameter and the error conditions are specified in the STANAG.
- Multicasting. It is necessary to allocate and reserve address space for multicasting and broadcasting in IP; extensions to IP to implement and manage multicasting are still to be defined.[2] Concepts for multicast addresses are described in detail in the STANAG.

5. TRANSPORT LAYER STANAGs

STANAG 4254 provides the transport service definition. Since NOSA (see Section 9.2.3.2) identifies no security services for the Transport Layer, there are no military-specific security services or protocol enhancements. The CO transport service (Annex C) is based on ISO 8072. The CL transport service (Annex D) is based on ISO 8072/AD1 (with the restriction that the note of paragraph 15.2.3 is not retained).

Annex E of STANAG 4254, *Real-Time Transport Service (RTTS)*, has been proposed as fulfilling the real-time military features for NATO military systems. Specifically, RTTS is designed to offer more functionality to such services as connection service and data transfer service and to provide additional services such as synchronization and management. RTTS provides services for broadcasting, selective broadcasting, and concentration. Chapter 2 of Annex E, *Definition of the Real-Time Transport Service (RTTS) Provided by the Transport Layer*, uses concepts, terminology, and structure similar to ISO 8072 for transport Classes 0, 1, and 2. RTTS appears to impact more than a single layer (Layer 4) and does not appear to fully conform to the Basic Reference Model ISO 7498.

Deficiencies and required enhancements in seven areas are noted in STANAG 4254 for both CO-mode and CL-mode transport services as shown in Table J-4 (internetworking is not applicable).

STANAG 4264 provides the transport protocol specification. The connection-oriented transport protocol (Annex C) is based on ISO 8073. End systems must implement transport protocol Classes 0 and 2; other classes may be implemented in addition. The deficiencies and enhancements to seven of the military features (internetworking does not apply) are given in Table J-5.

Annex D specifies the connectionless transport protocol, based on ISO 8602. Enhancements are the same as in Annex C with the following exception:

- Multihomed and Mobile Host Systems. Since no data acknowledgement is provided by the service, the protocol is not affected when a remote host system changes its SNPA and is not reachable temporarily.

Annex E specifies the connection-mode transport protocol over CONS, based on ISO 8073 and ISO 8073/AD2 (*Class Four Operation Over Connectionless Network Service*) using TP4. Enhancements are the same as in Annex C with the following exceptions:

- Multihomed and Mobile Host Systems. Since no network connection is released when a remote host system changes its SNPA and since TP4 offers error detection and recovery mechanisms, this protocol is not affected by this military feature.

Annex F of STANAG 4264, *Real-Time Transfer Protocol Over Connectionless Network Service*, is still to be defined.

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2 Draft STANAG 4263 identifies U.S. DoD RFC 1054, *Host Extensions for IP (DoD) Multicasting*, as the source for descriptions of the required extensions to ISO IP. See Appendix H.

Table J-4. Deficiencies and Enhancements Identified for STANAG 4254

(1)	Multihomed and mobile host systems. No requirement as the transport service is not affected by either the multiple attachment of a host to two or more nodes or subnetworks nor the change at any time by a host of network or subnetwork attachment.
(2)	Multiaddressing. The transport service does not provide any service or function related to multiaddressing. To specify the addresses of participants in a multipeer connection, the Group Address can be resolved into a number of ordinary addresses or the address parameters in the service definition can be redefined to permit the use of a list of addresses rather than just one.
(3)	Network/system management functions. Transport management service primitives are required to satisfy this requirement, and the primitives defined in ISO 9595 (CMIS) are satisfactory for the communication of information related to the Transport Layer managed objects. Specific management objects and functions need to be defined.
(4)	Security. According to the NOSA, no security services are specified for the Transport Layer and no security enhancements are required.
(5)	Robustness and Quality of Service (QoS). No enhancements required. QoS parameters are provided for data transfer service enabling the user to control and check the QoS. These parameters are negotiated during the connection establishment phase.
(6)	Precedence and preemption. No enhancements required. A QoS parameter is provided to express the priority of a transport connection. This parameter is negotiated during the connection establishment phase.
(7)	Real-time and tactical communications. In real-time communications, the requirement to have short transit delay for the transfer of data is more important than the requirement to have data delivered without sequence errors. There is also a requirement for such services as sampling process data transmission, periodic data transmission, and synchronization service, which are not provided by the ISO transport service. For real-time communications, the definition of services is for further study. For tactical communications, ISO transport services are suitable.

Source: *Draft STANAG 4254*, July 1990, NATO UNCLASSIFIED.

Table J-5. Deficiencies and Enhancements Identified for Annex C of STANAG 4264

(1)	Multihomed and mobile host systems. The protocol shall have the recovery mechanism of Classes 1, 3, or 4 in the case where the Network Service Provider releases the network connection each time the host system changes SNPA and the QoS requirement specifies low probability of unexpected connection release. If the classes 0 or 2 are used, the recovery of the connection shall be provided either in the Network Layer or in the Application Layer.
(2)	Multiaddressing. Savings in time and bandwidth can only be achieved if mechanisms are introduced into layers that inherently possess the ability to support communications to multiple destinations simultaneously (Layers 2 and 3).
(3)	Network/system management. Specific military managed objects for the Transport Layer will be specified when they are identified. They will be specified as extensions/modifications to the civilian managed objects.
(4)	Security. There are no specific security functions and no required enhancements.
(5)	Robustness and Quality of Service (QoS). Transport Layer specifications of the mechanisms needed to respect the QoS requirements are for further study.
(6)	Precedence and preemption. Transport Layer specifications of the mechanisms involved by the management of the priority are for further study.
(7)	Real-time and tactical communications. To be defined.

Source: *Draft STANAG 4264*, July 1990, NATO UNCLASSIFIED.

6. SESSION LAYER STANAGs

The two Session Layer STANAGs (4255 and 4265) have been developed by WG2 with the U.S. serving as editor. Both these STANAGs have been recommended by WG2 to be distributed by SG9 for ratification without military features.

STANAG 4255 is based on ISO 8326, *Basic Connection-Oriented Session Service Definition.* Annex D is reserved for connectionless session services. The only military deficiency areas identified in the draft STANAG are for security and multi-endpoint connection:

- Security. A mechanism for providing graceful closure may be required by NATO in the long term. At present, this requirement is insufficiently refined to allow a service realization. Therefore, no enhancement of ISO security measures can be provided at this time
- Multi-endpoint connection. ISO is currently considering multipeer data transmission requirements for the Session Layer. This activity will be monitored by the developer of this STANAG, and this paragraph will be updated as developments warrant. An enhancement requirement is contingent upon ongoing developments within ISO.

STANAG 4265 is based on ISO 8327, *Basic Connection-Oriented Session Protocol Specification.* An annex (Annex D) is reserved for information regarding the Connectionless Session Protocol Specification. The deficiencies and enhancements for STANAG 4265 are the same as for STANAG 4255.

7. PRESENTATION LAYER STANAGs

The two Presentation Layer STANAGs (4256 and 4266) have been developed by WG2. In addition, STANAGs have been drafted for ASN.1 (STANAG 4258) and the Basic Encoding Rules for ASN.1 (STANAG 4259). All four Layer 6 STANAGs have been recommended by WG2 to be distributed by SG9 for ratification without military features.

STANAG 4256 will initially be based on ISO 8822, *Connection-Oriented Presentation Service Definition.* An annex (Annex D) is reserved for connectionless presentation services. Potential deficiencies have been noted in three areas:

- Security (Annex B). NOSA has placed additional security-related services in the Presentation Layer, but these are not yet defined in detail. Modifications are anticipated in the ISO standards following ISO 7498-2, which may meet the emerging military requirements. No security enhancement to the ISO Presentation Layer is currently available. However, as solutions are available this STANAG will be amended.
- Mobile hosts and multihomed systems. No deficiencies noted (subject to change dependent upon the ability of the lower layers to support this feature).
- Multi-endpoint connection. Modifications will be needed to the Presentation Layer if multi-endpoint connections are required in an implementation, but no specific requirements have yet been identified. Modifications will be made to the ISO standard once the multipeer data transmission work in ISO has been progressed.

STANAG 4266 is based on ISO 8823, *Connection-Oriented Presentation Protocol Specification.* Annex D is reserved for the connectionless presentation protocol specification. The military deficiencies and enhancements for STANAG 4266 are the same as for STANAG 4256.

Separate NATO agreements will address ASN.1 (STANAG 4258) and the ASN.1 basic encoding rules (STANAG 4259). These are based on ISO 8824 and ISO 8825. No deficiencies were found in these based standards and no enhancements are recommended.

STANAG 4259 observes that additional sets of encoding rules for ASN.1 may be required for specific applications giving either compressed (minimum volume) or encrypted encodings. No specific requirements in this area have yet been identified. Following work in these areas by ISO, additional ASN.1 encoding rule STANAGs may be developed. A remark provided at the end of STANAG 4258 observes that ISO 8824/1 includes a note that makes reference to the encodings for the Real Type by the *Basic Encoding Rules for ASN.1* (ISO 8825)--this note is not relevant if alternative encoding rules are to be employed.

8. APPLICATION LAYER STANAGs

The only Application Layer STANAG that has been produced in draft form is the draft MMHS STANAG 4257. The status of the MMHS work is discussed in Appendix K. An initial focus meeting on FTAM was planned for June 1990 (see Appendix K).

The February 1990 draft MMHS STANAG identifies the STANAG as the Military Base Standard. The draft states that other STANAGs will define related MMHS profiles that will define additional requirements related to particular environments, but the May 1990 report of WG2 to SG9 states that the profiles will be included as separately ratifiable annexes to STANAG 4257. The draft STANAG has four annexes:

- Annex A, *Scenarios and Rationale*, provides detailed specification of the scenario of application and rationales behind the major decisions. It also discusses support of the subset of the eight military features that are applicable to a store-and-forward messaging environment.
- Annex B, *Military Message Handling System Extensions*, provides the set of extensions to civilian MHSs for Interpersonal Message Service required for military messaging.
- Annex C, *Security Aspects of MMHS*, identifies the service, protocol, and operational requirements related to security. This annex would be classified NATO SECRET.
- Annex D, *Gateway Translations*, provides detailed specification of the interface between MMHS and other messaging systems, including ACP systems [e.g., ACP 121 *(Communications Instructions-General)*, ACP 126 *(Communication Instructions--Teletypewriter/Teleprinter Procedures)*, and ACP 127 *(Communication Instructions--Tape Relay Procedures)*].

Table J-6 identifies the military features as they affect MMHS.

9. DEVELOPMENT OF OTHER TECHNICAL STANAGs

This section will identify non-OSI STANAGs that appear to be relevant to ATCCIS technical standards. Media-dependent STANAGs (e.g., on tactical data links) are not addressed.

9.1 Network Independent Interface (NIIF)

NIAG SG6 is developing a draft specification of a Network Independent Interface (NIIF). This was briefed to the TSGCE SG9 AHWG-OM in February 1989. NIIF is a concept for a combat system data distribution interface that could be used by the NATO Frigate Replacement for the 1990s (NFR90), a programme currently in a project definition phase.

Table J-6. Status of X.400(MHS)-1988 Relative to the Eight Military Features

(1) Multihomed/Mobile Host

(a) Multihoming applies to MMHS applications in two ways: multihoming UAs and multihoming MTAs. In the first case, the MHS must allow a single user to have more than one Originator/Recipient (O/R) name. The second case requires MTAs that answer to more than one name. In both cases, the capability in question is outside the scope of the communications standards, but is permitted as an implementation option. Capabilities for multihoming would have no direct impact on either MHS services or protocols, but are instead more focused on the lower layers.

(b) Similarly, mobile hosting can also be applied to either the MTA or UA. In either case, the key requirement to support mobile hosting is the capability for the functional object in question to disconnect from the network for a period of time without serious consequence. In MMHS there are two mechanisms to support mobile hosting of the UA. One such mechanism is the use of a message store (MS) to act on the UA's behalf while the UA is off line. The second mechanism is use of the Hold for Delivery element of service, in which the service element instructs the MTS to defer delivery of a UA's messages until a later time. No such mechanisms are available to the MTA, however.

(2) Multipeer Data Transmission (MPDT)

Since MHS applications are store and forward (i.e., connectionless) in nature, no end-to-end connections are provided or required by MMHS. However, the MMHS does provide a connectionless MPDT capability in the form of multi-addressed messages. This feature allows a single message to be sent to several recipients with a single submission to the MTS. The MTS is then responsible for performing traffic splitting at the appropriate time. Note that traffic splitting could be substantially more efficient if supported by a lower layer MPDT function.

(3) Internetworking

Internetworking is addressed by the provision of MMHS/ACP 127 and MMHS/civilian gateway definitions. Gateways could also be created to other systems that perform similar message handling functions, but such gateways are at present beyond the scope of MMHS.

(4) Network and System Management

Network management is a pan-layer issue that falls under the auspices of the AHWG-OM in SG9. The AHWG-MMHS will continue to identify MHS-related topics to be considered by AHWG-OM.

(5) Security

Security is a pan-layer issue that falls under the auspices of the AHWG on Security in SG9. The AHWG-MMHS will continue to identify MHS-related topics to be considered by the Security AHWG.

(6) Robustness and Quality of Service (QoS)

Most aspects normally associated with robustness and QoS have no meaning in the Application Layer. Three MHS characteristics have been identified as significant in terms of robustness and QoS: loss of messages, end-to-end delivery time requirements, and selection of security services. QoS aspects relating to link quality, hop-by-hop transmission delay, and throughput are primarily lower layer issues, and in any case have little meaning for a store-and-forward Application Layer process.

(a) Loss of message is addressed by the MMHS expansion of X.400's redirection capability. This provides a dead letter box at each MTA so that messages will always be delivered rather than discarded. MMHS also provides both delivery and nondelivery receipt capability to provide additional assurance of delivery.

(b) MMHS has specified end-to-end delivery time requirements consistent with those used by ACP 127. The hop-by-hop transmission delay and throughput necessary to achieve those end-to-end times are lower layer issues.

(c) Selection of appropriate security services is largely dependent on the security policy in force. This policy will determine what services will be enabled during the origination of a message based on its classification or other factors. This selection could be done either technically or procedurally, however, and thus is purely an implementation issue. Whatever solution is used will impact only the originator and will not require changes to the communication protocols.

Table J-6. (Continued)

(7) Precedence and Preemption The established requirement for military priority in message handling is four levels based on ACP 127. The MMHS base standard provides six priority levels in all protocols necessary to support the use of precedence and preemption in any implementation. However, it is the intent of the AHWG-MMHS to develop functional profiles that support six levels of priority in the UA-to-UA protocols but only three levels in the corresponding MTA-to-MTA protocols. Use of these provided information elements to support precedence and preemption in either the UA or MTA is an implementation issue.
(8) Tactical and Real-Time Communications MMHS has specified end-to-end delivery time requirements that are purported to represent the tactical environment. In addition, the AHWG-MMHS plans the development of a *Beta Profile* tailored to low bandwidth tactical applications.

Source: *Draft STANAG on Military Message Handling System*, 16 February 1990, NATO UNCLASSIFIED.

In a subsequent joint meeting with the NIAG SG6 and TSGCE SG9 WG1 in June 1989 [NIIF 1989], the NIIF was identified as a project to (1) put NACISA in the lead to resolve interface problems and provide management structure for such projects; (2) provide near- and mid-term standards specification for ACCIS interoperability; (3) initially develop interface specifications to pass character-oriented messages between existing systems; and (4) evolve the specification so that it will be suitable for other services (e.g., file transfer, virtual terminal). The specifications were to be based on ISO OSI standards and on functional profiles of SPAG and CEN/CENELEC that are adopted in the *NTIS Transition Strategy*: T.21 Permanent Circuit (telephonic), T.22 Switched Circuit (telephonic), and T.31 Permanent Access to a PSDN. BID-1000 and KG-84 were identified for communications security. The message handling area was based on A/3211 from the EWOS.

As early as September 1987, NIAG SG6 proposed a draft STANAG for *NATO Naval Intra-Ship Tactical Control and Data Handling Open Systems Interconnection, Network Independent Interface, Transport Service Definition for Connection-Mode Transmission* [NATO Naval 1987]. This proposal was based on ISO 8072 with "additions and deletions, where necessary, to reflect a unique Naval, intra-ship, interpretation to it." The NIIF is identified in this proposal as a collection of standards that provide the complete definition of an interface between the User and the Data Transfer System, based on unique requirements for real-time, fault tolerant information exchange between peer systems. [NIAG 1989] provides a statement of the programme of work planned by NIAG SG6 for 1990-1992.

9.2 Lightweight Protocols

The TSGCE AHWG on Restructuring has noted that the work of NIAG SG6 is closely related to the work of TSGCE SG9 on OSI standards. Both groups are interested in the area of lightweight LAN profiles for multi-Service use. The LAN profile being developed by NIAG SG6 is based on France's GAM-T-103, as is the U.S. SAFENET profile and the more general Express Transfer Protocol (XTP) profiles [Manno 1989].

The Xpress Transfer Protocol (XTP) is a lightweight (providing simplicity and low overhead) transfer protocol with unified internetwork services associated with OSI Layers 3 and 4. XTP conforms to the architecture of the Transfer Layer in RTTS developed in France for use in LANs (see Appendix K) [GAM 1987]. XTP is designed to support 100 Mbps sustained transfer rates between application programs with growth to 1 Gbps. XTP is designed to provide services for distributed systems not available in ISO TP4 and U.S. DoD TCP; the requirements include supporting remote procedure calls and rapid

request/response operations, coordinating multiple processes, and providing transaction-based file access. XTP supports traditional stream services, bulk transport, real-time reliable datagram service, real-time internet gateways, flow/error/rate control, message delivery confirmation, selective retransmission, message boundary preservation, multiple addressing plans, out-of-band signalling, reliable multicast mechanism, maintenance packets, and multipath capability [Chesson 1988; XTP 1989].

XTP has been submitted to ANSI X3.S3 for standardization of its services. Its standardization is also being progressed in the U.S. Navy SAFENET Committee.

9.3 EUROCOM and U.S./EUROCOM

EUROCOM is a technical working group composed of representatives from the NATO European nations whose aim is to achieve better coordination and interoperability in tactical communications systems between European Allied armies. EUROCOM is a subgroup of the EUROGROUP, an informal grouping of European governments within the framework of NATO. Rather than trying to agree on a single system, it is EUROCOM's plan to introduce communications systems in accordance with agreed operational requirements and basic system parameters in such a way that there is complete interoperability among systems built to EUROCOM standards. EUROCOM standards are frequently offered as the basis for NATO STANAGs on tactical communications [NACISC 1989].

The documents (D) currently promulgated by EUROCOM include:

- EUROCOM D/0: *System Concept*, CONFIDENTIAL (date of last revision unknown)
- EUROCOM D/1: *Tactical Communications Systems Basic Parameters*, 1986 (Revised September 1988), RESTRICTED
- EUROCOM D/2: (title and date unknown) subject is testing.

U.S./EUROCOM is an informal tactical communications technical working group comprising the EUROCOM nations and the United States, Canada, and France. The purpose of U.S./EUROCOM is to work toward better and less cumbersome interface arrangements, to monitor the implementation agreements on communications characteristics, and to promote cooperation in the procurement of equipment conforming to these characteristics. Much of the preliminary technical work leading to ratified standardization agreements is accomplished by this group.

With respect to work in OSI, the principal interest in U.S./EUROCOM is with the lower three layers. Currently, U.S./EUROCOM is in the process of modifying STANAG 4249, *The NATO Multi-Channel Tactical Digital Gateway--Data Transmission Standards (Packet Switching Service)*, to reflect the 1988 version of CCITT Recommendation X.75. U.S./EUROCOM is also investigating the application of the protocol implementation conformance statement (PICS)-type proformas to the NATO multi-channel tactical digital gateway STANAGs [NACISC 1989].

On many occasions U.S./EUROCOM has accepted invitations from TSGCE to work on the NATO STANAGs for tactical communications (not just gateways) and interoperability issues. U.S./EUROCOM has made major contributions to STANAGs 4206-4211 and 4350. Both EUROCOM and U.S. military standards are being considered for drafts of STANAG 4290, *Fiber Optics*. In each case the technical recommendations from U.S./EUROCOM are provided to TSGCE SG11 WG1 for further work, coordination, and distribution as draft STANAGs.

The work of U.S./EUROCOM in developing a profile for a tactical gateway for packet switching (STANAG 4249) was briefed the TSGCE SG9 WG1 in the October 1989 meetings in Brussels. In addition, Norway provided a paper[3] that suggested U.S./EUROCOM could undertake several tasks of interest to SG9. These include proposing protocol implementation conformance statement (PICS) proformas for the STANAG 4206-4214 series (and possibly others, such as STANAGs 4290 and 5040); proposing tactical parts of the STANAG 4250 series; identifying profiles required by the tactical communities in NATO; and proposing NATO functional profiles for tactical applications. However,

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[3] *U.S./EUROCOM's Role in Developing Profiles for NATO*, AC302/SG9/WG1-8910/15(NO), 2 October 1989, NATO UNCLASSIFIED.

U.S./EUROCOM's role in developing profiles for NATO is still under consideration and has not been fully accepted by U.S./EUROCOM.

9.4 Other Efforts

STANAG 4214, *International Routing and Directory for Tactical Communications*, may be applicable to ATCCIS technical standards; this standard is the responsibility of TSGCE SG11. TSGCE SG9 WG1 is looking at naming and addressing requirements and the applicability of STANAG 4214. STANAG 4249, *The NATO Multichannel Tactical Digital Gateway--Data Transmission Standards (Packet Switching Service)*, also the responsibility of SG11, addresses packet switching using a form of CCITT X.25; as such, this STANAG may also be applicable to ATCCIS technical standards. The Eurogroup on Cooperation of Tactical Communications Systems (EUROCOM) is reported to be preparing a revised draft for STANAG 4249 based on CCITT X.25 and the draft TSGCE SG9 Functional Profile Guidelines document; such a draft would be submitted to SG11 as a contribution and developed into a STANAG.

MILITARY INITIATIVES FOR USE OF OPEN SYSTEMS

1. Introduction

This appendix examines military efforts to specify and implement open system standards and architectures to achieve interoperability. The purpose is to (1) assess the progress being made to incorporate military requirements in international standards and to define, where necessary, extensions to those standards, and (2) identify the standards and profiles that may be applicable to CCISs. It is based on information produced by TSGCE and other NATO organizations through July 1990.

This section is followed by a discussion of the eight military requirements defined by TSGCE SG9 (Section 2) and an overview of SG9's organization and the plans and activities of the working groups (WGs) within SG9 (Section 3). (Details of the work of TSGCE SG9 are provided in Appendix I and the status of the OSI STANAGs in Appendix J.) Section 4 identifies the scope and relationship of the *NATO C3 Architecture* and *C3 Master Plan.* Section 5 identifies open systems standards in seven NATO CCIS initiatives. U.S. DoD and civil initiatives for use of open systems are identified in Sections 6 and 7 (details of some of these U.S. initiatives are found in Appendix C). Results the assessment are provided in Section 8.

2. Military Requirements for OSI

This section summarizes the requirements associated with incorporating military enhancements into open systems interconnection (OSI) standards. Within NATO, this work has been assigned to TSGCE SG9. General information on NATO and international standards bodies concerned with OSI standards is provided in Appendix F.

Beginning in February 1983, a number of military requirements have been identified in NATO that are not adequately covered by existing OSI standards. Eight military features were identified in the NATO Interoperability Management Plan (NIMP) [ADSIA 1988], and TSGCE SG9 has recommended that the OSI Reference Model (STANAG 4250) be extended to provide support for these features:

- Multihomed, mobile host systems
- Multi-endpoint connection
- Internetworking
- Network/system management functions
- Security
- Robustness and quality of service
- Precedence and preemption
- Real-time and tactical communications.

Table K-1 gives the description of the eight military features as provided in *Use of OSI Standards in NATO--Strategic and Technical Issues,* March 1988 [U.K. 1988].

Table K-1. Eight Military Features for Enhancing OSI in NATO

(1)	Multihomed and mobile host systems. Multihoming is a mechanism for attaching an end system to two or more network access points without the need for a system setting up a call to it to be aware of the extra connectivity. In addition to enhancing survivability, this facility may be extended to support "mobile hosts" such as aircraft and ships.
(2)	Multi-endpoint connections [multi-addressing; multipeer data transmission (MPDT)].[1] In order to transmit data to a number of recipients, it is usually necessary to establish several connections and send separate copies of the data across each connection in turn. More efficient use is made of the communications resources if the sender has to transmit only one copy of the data. The network then takes care of routing, control, and distribution of the data.
(3)	Internetworking. Mechanisms are required to facilitate the interconnection of various NATO systems at the boundary point between subnetworks.
(4)	Network or system management functions. Management functions are required that may be of greater sophistication than those considered satisfactory for civilian networks. Management of broken networks in which layers of protocols are inoperable and fast responses to changes in network topology are essential to maintain important connections.
(5)	Security. Protection measures are required to prevent unauthorized access to information, preserve the integrity of data, and to mitigate against denial of service. [Note: Security includes access control, authentication, integrity, and confidentiality.]
(6)	Robustness (resilience) and quality of service. The range of quality of service parameters required for military systems exceeds that currently permitted within commercial OSI networks. In particular, in order to maximize the survivability of a network, the NATO aim is to maintain an adequate quality of service to the users (or at least to users operating above a given priority level) in the face of a severely damaged or partitioned network.
(7)	Precedence and preemption. In order to minimize congestion, particularly in a damaged network where resources are at a premium, it is desirable to be able to allocate resources on the basis of priority levels assigned to the connections being routed through the congested area. A facility is therefore required to associate a priority level with a connection when it is established.
(8)	Real-time and tactical communications. Certain applications are prepared to sacrifice such aspects of quality of service as sequencing and guaranteed delivery to achieve the minimum possible transit delay.

Source: *Use of OSI Standards in NATO--Strategic and Technical Issues,* Issue 2, TSGCE SG9, March 1988, NATO RESTRICTED.

A top-level view of how the eight military features identified above could potentially affect the layers of the OSI Reference Model is provided in Table K-2. The entries in the table are based on the most recent editions of the draft OSI STANAGs (see also Appendix J). This table is only an example of how the military features could potentially affect the layers of the OSI Reference Model; other sources would undoubtedly complete the table differently. The United States Data Communications Protocol Standards (DCPS) Technical Management Panel (DTMP) (formerly the PSTP) has reduced the number of military features to five, indicating, for example, that internetworking is no longer a required military feature because commercial international standards have developed significantly since the military features were first identified. TSGCE Subgroup 9 is considering reducing the number to three: Security, Quality of Service, and Network Management [PSSG 1991, 7].

[1] As indicated in Section 6.2.1, work in ISO on MPDT has been suspended in SC21/WG1. The completed work is planned to be released as a Technical Report. Canada is serving as the point of contact within SG/9 for maintaining interest in MPDT in ISO. Canada has introduced a draft proposal in ISO for Multi-Party Communications that would address MPDT.

Table K-2. Impact of Military Features on Layers of OSI Reference Model

Military Feature	OSI Layer 1	2	3	4	5	6	7
1. Multihomed, Mobile Host Systems			TBD				X
2. Multi-Endpoint Connection			X			TBD	X
3. Internetworking			TBD				
4. Network/System Management Functions	TBD	TBD	TBD	TBD			X
5. Security	X		X			TBD	X
6. Rubustness and Quality of Service	TBD		X	TBD		TBD	TBD
7. Precedence and Preemption			X	TBD			X
8. Real-Time and Tactical Communications			TBD	TBD		TBD	TBD

Key: X = A deficiency has been identified in the applicable draft STANAG.

Sources: *Use of OSI Standards in NATO-Strategic and Technical Issues,* Annex 6, *Summary of Impact of Military Feature on Layers of Reference Model,* TSGCE SG9, 1 March 1988, NATO UNCLASSIFIED; *Commentaries on the STANAGs of WG1,* Contribution by France to TSGCE SG9/WG1, February 1989, NATO UNCLASSIFIED; the *NATO OSI Security Architecture (NOSA),* March 1988, NATO UNCLASSIFIED; and recently released draft OSI STANAGs (through July 1990).

With respect to the eighth military feature, "Real-time and Tactical Communication," MITRE developed a proof-of-concept prototype system to test the applicability of GOSIP protocols in the tactical environment and concluded that the full OSI protocol stack could be used for tactical messaging if the use of OSI Congestion Avoidance is required and the number of Message Transfer Agents (MTAs) that must be traversed is minimized. In addition, the architectures of the implementations must focus on efficient queue handling and connection handling [Messing et al. 1990].

3. Work of TSGCE SG9 for OSI STANAGs

The foundation for an assessment of the progress in NATO for adapting to and, where necessary, defining military enhancements for OSI standards is a review of the activity and work plans of SG9. Following a summary of the TSGCE SG9 organization and responsibilities, the activity for developing the *NTIS Transition Strategy* is discussed in Section 3.2. The status of the OSI STANAGs is summarized in Section 3.3 of this appendix and reviewed in depth in Appendix J. A discussion of the current activity and work plans of the WGs of SG9 is in Section 3.4 of this appendix.

3.1 Responsibilities of TSGCE SG9

TSGCE SG9 has the primary responsibility in NATO for reviewing the military requirements, identifying the potential impact on the OSI standards planned for use in each of the seven layers of the ISO and NATO Reference Models, defining the deficiencies and services required to address these requirements at each layer, and developing draft

STANAGs that conform to the Reference Model and provide for the needed services. SG9 has three WGs and three ad hoc working groups (AHWGs)[2]:

- WG1, responsible for Layers 1-4 and functional profiles, within which the functional profile work is carried out by an AHWG on Functional Profiles.[3]
- WG2, responsible for Layers 5-7, within which the work on the Military Message Handling System (MMHS) is carried out by an AHWG on MMHS.
- WG3, responsible for establishing a memorandum of understanding (MOU) for a multinational program for Communications Systems Network Interoperability (CSNI)--not a permanent WG; work on the MOU is expected to be completed in December 1990, at which time WG3 would be disbanded.
- AHWG on OSI Management (AHWG-OM).
- AHWG on Integrated Services Digital Network (ISDN).
- AHWG on Security.

TSGCE SG9 maintains liaison with many NATO bodies and agencies, including ADSIA, TSGCE SG11 (Tactical Communications), TSGCE PG6 (Tactical Communications Systems for the Land Combat Zone--Post 2000), NATO Industrial Advisory Group (NIAG) SG6 (Compatibility of Naval Data Handling Equipment), ATCCIS PWG, and Allied Tactical Communications Agency (ATCA).

3.2 NTIS Transition Strategy

A major project of TSGCE SG9, led by the German delegation, is the development and maintenance of the *NTIS Transition Strategy*. The current version is the 1989 or Fifth Edition; it is dated 30 November 1989 [NATO 1989] and was directed to be distributed by SG9 in May 1990. This document is revised annually and promulgated by the CNAD. It provides recommendations for international commercial standards, primarily from ISO and CCITT, and intercept strategies (stacks of standards) that can be used by the nations as part of a transition strategy prior to the promulgation of OSI STANAGs. The *Intercept Profile for Military Message Handling Systems,* based on CCITT X.400-MHS(84), was included in this edition. The Fifth Edition also incorporates ISDN standards and the 1988 recommendations of CCITT. It describes 4 application, 17 transport, and 11 relay profiles. A summary of the standards and profiles contained in the Fifth Edition of the *NTIS Transition Strategy* is provided in Section 6.3, especially Tables 14, 15, and 16 and Figure 10. The profiles are illustrated in Appendix B.

A draft of the next edition of the *NTIS Transition Strategy* is expected to be provided in the fall of the 1991. The new version will include use of the new ISO TR 10000 taxonomy. The taxonomy of application profiles is expected to be removed

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2 SG9 is currently considering a new organization of its working groups that would phase out the current working groups in two years.

3 The AHWG on Functional Profiles has recommended that the content and structure of a NATO functional profile be based on ISO TR 10000. Review of this document shows that TSGCE SG9 intends to specify recommended standards for multiple layers at the interoperability parameter level.

from the *NTIS Transition Strategy* and included in the *Functional Profile Guidelines*[4] document being developed in WG1. Emerging standards not addressed in the Fifth Edition that could be considered for the next edition of the *NTIS Transition Strategy* are ODP, TM, security protocols, X-Protocol (X-Windows), GKS, CGI, PHIGS, CGM, SQL, IRDS, and RPC.

3.3 Status of OSI STANAGs

Table K-3 identifies the STANAGs being developed that will specify ISO standards and applicable military options and extensions, if any. Work has begun on all these STANAGs, but only STANAG 4250, the NATO Reference Model, has been ratified. Originally, TSGCE SG9 planned to issue a single STANAG for all services and a second STANAG for all protocols at each layer, giving a total of 14 STANAGs in addition to STANAG 4250, the NATO Reference Model. In October 1987, TSGCE SG9 agreed [U.K. 1990, Annex 1.2] to work at the Application Layer for single STANAGs for each Application Layer service, such as MMHS (STANAG 4257). Protocol specifications as well as service definitions would be addressed in that STANAG. This approach will require editorial changes in STANAG 4250.

Table K-3. NATO OSI Standards

OSI Layer	Service Definitions		Protocol Specifications	
	STANAG	Draft Published	STANAG	Draft Published
Reference Model	4250 Ed 1 4250 Ed 2 Prt 1	Apr 86 (Ratified) May 90 (Draft)[a]	-	-
1	4251	13 Jul 90	4261	6 Jul 90
2	4252	Jul 90	4262	Jul 90
3	4253	Jul 90	4263	Jul 90
4	4254	Jul 90	4264	Jul 90
5	4255	12 April 90	4265	12 April 90
6	4256 4258 (ASN.1)	19 Jan 90 15 Jan 90	4266 4259 (ASN.1 BER)	19 Jan 90 19 Jan 90
7	4257(MMHS)[b]	16 Feb 90	4257(MMHS)[c]	16 Feb 90

[a]The May 1990 draft of STANAG 4250 is being circulated to the Nations for ratification.
[b]Multiple STANAGs are planned for Layer 7; STANAG 4257 will address MMHS.
[c]For Layer 7 there will be a single STANAG for each pair of related Application Layer Service Definitions and Protocol Specifications.

When stacks of standards, options, and interoperability parameters that involve more than one OSI layer are selected for open systems interconnection for data processing and distribution systems, the agreements will be specified in documents that are to be known as standardized profiles. NATO standardized profiles, initially to be drafted by TSGCE SG9, will be based on the OSI STANAGs 4250-4259 and 4261-4266. To date, the standardized profiles promulgated by TSGCE SG9 are contained in the *NTIS*

4 The July 1990 meeting of the TSGCE SG9 WG1 Ad Hoc Working Group on Functional Profiles determined to use the term NATO Standardized Profiles rather than Functional Profiles to be in line with ISO TR 10000, which discusses International Standardized Profiles.

Transition Strategy and are all based on commercial international OSI standards and the OSI STANAGs. These profiles (application, transfer, and relay) are identified in Tables 14, 15, and 16 of Section 6.3 and illustrated in Appendix B.

STANAG 4250, *NATO Reference Model for Open Systems Interconnection,* is being revised and the new draft developed in the May 1990 TSGCE SG9 plenary meeting is being circulated to the Nations. The new STANAG will be in five parts, only the first of which is ready for ratification The first four parts conform to the current structure of the *OSI Basic Reference Model,* ISO 7498:

- Part 1--*General Description*
- Part 2--*Security*
- Part 3--*Naming and Addressing*
- Part 4--*Management*
- Part 5--*Military Features.*

Two additional parts (*NATO Functional Profile Guidelines* and *Conformance Testing*) were separated from STANAG 4250 and will be drafted and ratified separately; the format for publication of the two documents has not yet been determined. In May 1990, SG9 agreed to reissue Edition 2 of STANAG 4250 as described above without going through a formal ratification process [Schultz 1990]. Thus, STANAG 4250 has been forwarded to the TSGCE for promulgation.

During its meetings in February 1989, TSGCE SG9 WG2 addressed the impact of the eight military features on the Session and Presentation Layers, especially for security, quality of service, and multipeer data transmission. WG2 determined that for both the Session and Presentation Layers there are no military features that have been defined, that are needed in the near term, and that are not supported by the OSI standards. WG2 has therefore forwarded the draft STANAGs for the Session and Presentation Layer (STANAGs 4255, 4256, 4265, and 4266) and ASN.1 (STANAGs 4258 and 4259) to TSGCE SG9 for ratification; TSGCE SG9 decided in March 1989 to distribute these drafts to the nations to begin the ratification process. These drafts were modified by WG2 in February 1990 and provided to SG9 in May 1990. SG9 identified a number of editorial problems with the draft STANAGs, requested these be addressed by WG2, and asked for revised drafts at the December 1990 SG9 plenary meeting.

3.4 Current Work on OSI STANAGs

This section identifies current work on the OSI STANAGs. The first three sections focus on WG1, WG2, and WG3, respectively. Media-Independent Data Link Architecture (MIDLA) is addressed in Section 3.4.4. Next, the work of four AHWGs is described: OSI Management, ISDN, Security, and MMHS. Note that MMHS is an AHWG of WG2, but its work is sufficiently broad and important to CCISs that it is treated separately from WG2.

3.4.1 WG1: Developing Lower Layer OSI STANAGs

The two primary tasks of WG1 are developing lower layer STANAGs (the first issues are planned for submission to SG9 in October 1990) and developing guidelines for

standardizing NATO standardized profiles. The status of these activities is summarized below [WG/1 1989; WG/1 1989a; WG/1 1989b; TSGCEE 1989; WG/2 1990].

WG1 has agreed to prepare all the lower layer STANAGs for submission to SG9 by the October 1990 WG1 meeting. If possible, example profiles, Conformance Statements, and NPICS Proforma will be included. At present, the draft STANAGs do not explicitly require Transport Protocol TP4 to support connectionless operations, and they may not include the annex for Layer 3 (Annex F) on the connectionless Internet Protocol (IP). Revised drafts of the lower layer STANAGs were tabled at the July 1990 meeting of the AHWG-FP. WG1 has determined [TSGCEE 1989] that it is inappropriate for forward error correction (FEC) to be standardized with the OSI framework; therefore, WG1 has relegated FEC as actions to be accomplished on the information bit stream outside the Reference Model. Thus, FEC is not currently being considered in the lower layer STANAGs.

A Functional Profile (FP) Guidelines document is being developed; it is viewed in WG1 as the basis for the lowest common denominator of interoperability. This document is being developed in WG1, but WG2 will be requested to provide formal comments and will be invited to participate in future AHWG-FP meetings. The FP Guidelines document is based on ISO TR 10000 (Part 1--*Framework* and Part 2--*Taxonomy*). WG2 has no strong reservations against the FP Guidelines or the TR 10000 taxonomy and structure for standardized profiles. However, WG2 expressed the need to continue their message handling work in the EWOS format in order to maximize their interchange of information with EWOS. WG2 would translate their MMHS STANAG work into the TR 10000 structure at a time when that structure was more stable for the upper layers.

WG1 has been reviewing a number of technical papers on lower layer addressing. These include the *EWOS Technical Guide to OSI Layer 1 Through 4 Addressing* and a draft British Standards Institute guide for *The U.K. Scheme for the Allocation of ISO-DCC Format OSI Network Service Access Point (NSAP) Addresses*, which was used in the EWOS document as a reference for addressing in Layer 3. The United States has submitted papers on naming and addressing and on the compatibility of STANAG 4214 and U.S. GOSIP Network Layer addressing. The United Kingdom has developed a rationale for Annex D of draft STANAG 4263 with the goal of resolving differences with STC in an addressing scheme.

Since ISO restricts the Transport Layer levels of precedence to 15 by restricting use of one of the levels, WG1 agreed to reduce from 16 to 15 the number of levels of precedence that would be adequate at the Transport Layer.

WG1 has specific proposals for incorporating real-time aspects into the Layer 4 STANAGs. There are issues regarding these real-time services as to their conformance to OSI, differences from CCITT real-time work, and the interest of several nations in other efforts [e.g., U.S. Manufacturing Automation Protocol (MAP) real-time work] as closer to OSI.

3.4.2 WG2: Developing Upper Layer STANAGs

The first issues of the STANAGs for the Session Layer, the Presentation Layer, and ASN.1 have been submitted to SG9 without any military enhancements. Some minor changes were made in February 1990. Some additional editorial changes were directed by SG9 in May 1990 and action to begin ratification was deferred. WG2 will make the

required changes in October 1990, and the ratification process is expected to be directed to begin by SG9 in December 1990 [TSGCEE 1989; WG/2 1990].

Military organizations such as NATO need to make provision for an appropriate registration authority to ensure unique addressing of military organizations and users within MMHS domains and to assign object identifiers for MMHS (and other application service element) information objects. Registration authority can be technically independent for Application Layer addressing and information objects and for network addresses, but NATO may wish to consider these two issues concurrently.

WG2, like WG1, has been working on lower layer addressing. WG1 has been discussing two principal scenarios, one in which NATO is registered as a network addressing authority under the ISO 6523 scheme and allocates Network Service Access Point (NSAP) address space to users, and another in which NATO is *not* so registered and each member nation allocates from its own delegated address space the NSAP address space for NATO use. It has been noted [U.K. 1990] that if NATO becomes a network addressing authority, it will not prejudice the ultimate choice of which scenario to pursue and that such authority is needed for reasons other than NSAP addresses.

SG9 has considered recommendations drafted by the AHWG on MMHS put forward by WG2, but has decided to postpone action on this issue. SG9 decided to hold a meeting during 8-10 October 1990 with NACISA, national experts, and SG9 experts in attendance to formulate a method of work and joint recommendations for technical and administrative assessments on naming and addressing, and NATO as a registration authority [TSGCEE 1990].

Revised working drafts of the MMHS(88) rationale, base standard, and two interoperability profiles have been produced. The current work is not yet stable (see Section 3.4.8 of this appendix). MMHS(84) gateways, directories, PICS proforma, and management requirements still need to be considered. The June 1990 meeting of the AHWG on MMHS (in the United States) addressed MMHS profiles.

WG2 scheduled an initial focus meeting on FTAM for June 1990. The goals were: a statement on the current status of FTAM (including profiles and products); a requirements document outlining requirements for file transfer; determination of base standard and profile enhancements; and a work plan. Only three nations, Germany, the United Kingdom, and the United States, identified a requirement for FTAM [PSSG 1991].

WG2 plans [WG/2 1990a] to maintain close liaison with NACISA, particularly on the development of FTAM profiles, as NACISA has undertaken work in this area. NACISA is attempting to meet a requirement identified by the United Kingdom to transfer large unstructured files. Civilian profiles lack security features to support this requirement.

3.4.3 WG3: Communications System/Network Interoperability

An Ad Hoc Group on Nunn Initiatives was formed by TSGCE SG9 in March 1988 to progress three projects as multinational cooperative efforts. In part, these proposals were aimed to satisfy a request from ADSIA to TSGCE to investigate the feasibility of a transmission-media-independent data link architecture; such an architecture and the associated technical standards are needed to support stated requirements of the Air Command and Control System (ACCS, see Section 5.3 of this appendix). The three original proposals were to:

- Develop, test, and implement techniques for Communications System/Network Interoperability (CSNI)
- Develop an architecture for future data links based on the NATO Reference Model
- Produce draft STANAGs for the products produced in the other two projects.

IATO funds for the last two proposals have not been found.[5]

WG3 was formed in October 1989 to develop an MOU under a Nunn Initiative for :SNI. Canada, France, and the United States have signed the formal Statement of Intent or participation; the United Kingdom, Netherlands, and STC have also expressed interest 1 participating. WG3 tasking will end with a completed MOU among the participating ations, but the project itself will take about 3 years. The emphasis of this 3-year effort is ot on developing standards but rather to demonstrate the operational utility of iternetworking using enhanced OSI profiles with military features. While completion of 1e MOU is planned for December 1990, the Chairman of SG9 has suggested that WG3 be ept as an AHWG within SG9 [Schultz 1990].

The CSNI project plans a demonstration in 1993 for linking subnetworks of ountries across long haul multimedia supporting multiple modes (voice, data, images). ccording to the January 1990 draft MOU [WG/3 1990], WG3 will (1) ensure that the ork will be closely related to the recommendations, standards, and draft STANAGs of all roups under SG9; (2) provide both feedback into the STANAG development process and ractical experience on the implementation of OSI protocols on military bearer systems; (3) rovide reports on the demonstration results and performance to SG9; and (4) based on emonstration results, recommend to SG9 the adoption of promising system concepts for ifferent operational applications.

3.4.4 Media-Independent Data Link Architecture (MIDLA)

MIDLA was suggested to TSGCE by ADSIA in 1986 [ADSIA 1986]. During the eriod 1987-1989, the Nations attempted to identify Nunn Initiative funding for MIDLA, ut these efforts were unsuccessful. At the October 1989 SG9 plenary meeting TSGCEE 1989], the Nations agreed that development of a data link architecture based on 1e OSI Reference Model to replace antiquated data links was extremely important. Iowever, it was also agreed that resources were not available within SG9 to address the readth, complexity, and technical aspects of that subject. SG9 agreed to send a letter to 'SGCE stating the importance and magnitude of this project. In addition, the Nations were sked to assess again the availability of resources relative to the MIDLA project.

Some bilateral work between France and the United Kingdom is being discussed :garding future data link architectures. Further, ADSIA has received an STC study, *An rchitecture Based on OSI Principles for NATO Tactical Data Links* [SHAPE 1989], and as indicated to TSGCE SG9 that no further work on behalf of ADSIA is required for IIDLA [MIDLA 1990]. However, tactical data link architecture is being addressed by the 'SGCE AHWG on restructuring as a potential area of work. SG9 has indicated that if the

U.S. DoD support for the second and third items was not provided, apparently due to lack of funds.

SG9 terms of reference are amended to include tactical links, guidance from the TSGCE would be required on providing necessary resources [Schultz 1990; TSGCEE 1990b].

3.4.5 AHWG on OSI Management

The lead for NATO initiatives on network management is the AHWG-OM, which addresses such pan-layer areas as fault management (detect, isolate, and correct abnormal operation); configuration management (exercise control over identities and collect data from and provide data to managed objects in order to assist in providing continuous operation of interconnection services); security management (enable the management of the information necessary for providing security services); accounting management (enable charges to be established, and costs to be identified, for the use of managed objects); and performance management (evaluate the behavior of managed objects and the effectiveness of communication activities). Specifically, the AHWG-OM was established to:

- Define the requirements for management in a military OSI environment.
- Investigate the influence of the military features (see Section 2 of this appendix) on the OSI management standards under development by ISO. The AHWG-OM has determined that the eight military features will affect, to varying degrees, all management areas.
- Influence ISO, and other standards bodies as appropriate, to adopt any additional military features identified.
- Develop any additional military management standards for the requirements not met by ISO.
- Assist in the coordination of management work within NATO and provide support for OSI management to SG9 and its permanent and ad hoc working groups.

The work of the AHWG-OM has been focused on influencing ISO work; in addition, work has begun on a draft STANAG covering OSI management. Many members of the AHWG-OM are also members of ISO committees, and the AHWG-OM believes its work is recognized by ISO in SC21/WG4 as a major contribution to the development of standards [TSGCEE 1990b].

Many of the ISO network standards have been reorganized and now appear to have a stable framework in ISO (see Section 9.3.3). A new set of functions has been developed, and the model of management information has been significantly modified. The Common Management Information Service (CMIS) and Protocol (CMIP) are now International Standards (ISO 9595 and 9596).

The AHWG-OM has noted that little military influence has yet been brought to bear on Security Management, for which work is progressing very slowly in ISO. The responses to a requirements questionnaire distributed in June 1989 indicated that almost all network management practices were manual and procedurally oriented and were not relevant to what ISO is trying to standardize in Network Management. However, the results of the questionnaire confirmed the earlier military analysis document in the Working Document *NATO Requirements for OSI Management* (an evolving record/base document of the AHWG on OSI Management results) [TSGCEE 1988]. Enhancements to this document--specifically in Section 7, "Military Features and Their Impact on OSI

Ianagement"--arising from the questionnaire were adding the needs (1) for a broadcast acility, (2) for a capability to apply management in real time, (3) to define and work across ıanagement domains, (4) to define access control mechanisms for management ıformation, and (5) to provide for survivability of management information (replication ıechanisms). Requirements for performance management, event reporting, and ıanagement negotiation were dropped [Gutman 1990].

In the February 1990 AHWG-OM meeting a formal contribution, addressed from ndividual nations to ISO, was drafted requesting adoption of Quality of Service (QoS) as a ew work item by SC21/WG1, in response to Question Q62 on QoS. If QoS is accepted, he AHWG-OM will need to concentrate on the management-specific aspects of QoS, specially notifications.

3.4.6 AHWG on ISDN

An AHWG on ISDN was formed by TSGCE SG9 in 1989 to review the status of SDN and the applicability of these standards to NATO. An overview of the eight military eatures was adopted at the April 1990 meeting. Table K-4 provides the initial approach to ddressing military features for ISDN and Table K-5 the details of those features for ISDN AHWG-ISDN 1990].

Table K-4. Initial Approach to Military Features for ISDN

1) Identify the ISDN domains to be standardized to assist the development of consistent ISDN standards within NATO countries and, in addition, to fulfill interoperability requirements and facilitate the development of a NATO Communications Subsystem.
2) Identify ISDN civil standards applicable to the systems involved in a NATO Communications Subsystem.
3) Review the capability of ISDN to support relevant military features, interworking requirements from tactical users/networks, and other NATO user service requirements.
4) Consider specifying enhancements to ISDN civil standards to meet a minimum military requirement.
5) Determine the impact of ISDN on the NTIS defined by SG9 in accordance with the NATO Reference Model, for example, the NTIS on network management and security.
6) Submit technical papers to SG9 for candidate profiles and/or STANAGs.
7) Submit a report to SG9 at each meeting.

ource: *Terms of Reference for TSGCE SG9 AHWG on ISDN,* NATO UNCLASSIFIED.

The AHWG on ISDN is discussing the ISDN Reference Model and has considered apers from France (based on the CCITT Reference Model and the *NATO C3 rchitecture*), ETSI, and ECMA. These models describe network-to-network ıterworking, including CCITT No. 7 and QSIG (an extension of Q.931) protocols.

Discussion of essential bearer services for ISDNs used for NATO communications esulted in a two-page recommendation for the Network Bearer Services [viz., 64-kbps ircuit switched (CS) unrestricted as in I.231.1, CS speech as in I.231.2, CS 3.1 kHz udio as in I.231.3, CS access to packet switching node as in I.231.1, B-channel packet witched access as in I.232.1, and D-channel packet switched access on the Basic Rate nterface as in I.232.1] and the Terminal Bearer Services. Further study has been ecommended for Frame Relay (I.122), Frame Switching (I.122), user-to-user signalling [.232.3), 7 kHz audio, 2x64 kbps unrestricted, H0--384 kbps unrestricted, H11--1536 bps unrestricted, and H12--1920 kbps unrestricted.

Table K-5. Military Features for ISDN

(1)	Mobile Hosts and Multihomed Systems. A number of scenarios are being discussed, some outside the ISDN domain (e.g., in the tactical area) and some within the strategic ISDN domain (e.g., as user moving from one PABX to another). Only strategic ISDN domain issues are currently being addressed in the AHWG on ISDN. It was agreed that ISDN Suspend/Resume procedures for moving during a call were not applicable to mobile hosts. Some form of slow mobility is required where a user may, for example, move between extensions on the same access switch or even to a different access switch and still maintain the same user identify. This would require a type of registration and cancellation procedure where a user takes the user identity around a fixed network. Specific NATO procedures may be required to realize this feature--further study is required. Procedures associated with the cellular radio service are issues mainly applicable to the tactical domain.
(2)	Multi-Endpoint Connections. Information needs to be multicast (or broadcast) to several destinations. A central issue is whether a unidirectional service was required for this feature: (a) If the requirement were defined in terms of a conference call (bidirectional), then commercial products are expected to be available. (b) If broadcast facilities were provided at the Application Layer using packet procedures, no specific NATO procedures are required. (c) If broadcasting were required on all bearer services (e.g., voice and data), then the AHWG on ISDN should wait for CCITT/ETSI to define this feature. It was generally agreed that the multi-endpoint feature is for data application rather than voice; further study is required on the requirement for voice.
(3)	Internetworking. The *NATO C3 Architecture* (Volume 4, *Communications Subsystem*) allows both the "T" reference point and the K, M, and N reference points as possibilities for internetworking. If the "T" reference point were chosen, then a number of enhancements would be required for NATO, such as satellite and routing indicators.
(4)	Network and System Management. CCITT is defining a network management structure in both the user-network area (Q.940) and within the network. This work is at the architectural level and has not resulted in a definition of detailed procedures. Of particular interest to SG9 are the management functions of Section 3 of Q.940 for fault, configuration, accounting, performance, and security management--all aligned with OSI management functions. In addition, management reference models have been defined.
(5)	Security. Key issues are the applicability of NOSA to ISDN (for data services), the impact of ISDN on NOSA (e.g., security of voice services, protection of signalling channels), and the definition of new security features using ISDN capabilities (e.g., common channel signalling). The first two issues are for the AHWG on Security. The AHWG on ISDN will propose ISDN security features relevant to the third issue (e.g., supplementary services) for approval by security experts of SG9.
(6)	Robustness and Quality of Service. The only possible special NATO requirement identified is the QoS parameter, should the ISDN network performance figures given in I.350 not prove to be adequate for military applications.
(7)	Precedence and Preemption. This feature is already being addressed (service definition and information).
(8)	Real-Time and Tactical Communications. No special real-time requirements are foreseen for ISDN. Note that the discussion was limited to interworking with a tactical network and to the concept of a strategic ISDN activity either as a transit network or to gain access to an ISDN user.

Note: The suitability of the ISDN protocols for use in the tactical domain was agreed to be outside the scope of the assessment leading to these requirements.

Source: *Report of the 2nd Ad Hoc Meeting on ISDN, Paris, 24-26 April 1990*, TSGCE SG9 AHWG on ISDN, May 1990, NATO UNCLASSIFIED.

One proposal (submitted by the United States) suggests the following as the basis for a draft STANAG on ISDN for packet mode services [AHWG-ISDN 1990a]:

- Networks shall support a packet-switching capacity in conformance with the 1988 CCITT recommendation on packet-switched data, X.31/I.462, *Support of Packet Mode Terminal Equipment by an ISDN*. At the user interface for the

Basic Rate Interface, both B channel and D channel packet switching will be supported. At the Primary Rate Interface, B channel packet switching will be supported. Terminals that support X.25-based packet switching will also conform to X.31.

- Conditional notification shall be supported on switched access connections. On permanent virtual circuits, the option of "no notification" shall be available.

3.4.7 AHWG on Security

The AHWG on Security has developed three major references for use in SG9: *NATO OSI Security Architecture (NOSA)* [NOSA 1988], *Security Architecture for NATO Information Systems Interconnection (SANISI)* [SANISI 1989], and the *NATO Network Security Information Classification Guide* [NATO 1989a]. NOSA was developed to give guidance to contractors and procurement managers on the preferred placement of security services within OSI-conformant systems. SANISI provides detailed rationale on the placement of security services and mechanisms within the OSI Reference Model. A key element of SANISI is the requirement in Layer 3 for a Trusted Communications Sublayer (TCS). NOSA and SANISI do not identify a requirement for security protocols for Layer 4.

Two security protocols (SP3 and SP4) have been introduced into ANSI from SDNS [TSGCEE 1989]. SP4 has been accepted as a work item in SC6/WG4 in ISO, and SP3 is expected to be accepted when some additional work on SP3 is completed in 1990. SP3 is the protocol most closely aligned with TCS. Since the distribution of NOSA and SANISI, the AHWG on Security has been addressing questions regarding the security protocols that have been introduced for Layer 3, including SP3, Northern Telecom's SPX, and the U.K.'s End-to-End Security Protocol (EESP). SP3 was judged as equivalent to the end-to-end encryption portion of the TCS. SPX adds connection-oriented service to SP3. The EESP adds CO services to SP3 and includes integrity and traffic padding.[6] The AHWG on Security anticipates that SG9 should be able to arrive at a Layer 3 protocol that will satisfy NATO military requirements [AHWG-ISDN 1990a].

Discussion of SANISI has included proposed annexes on application and implementation aspects of the TCS and the Denial of Service definition. Agreement has been reached that once an event object is defined, the recovery mechanisms are the same whether the cause was malicious or accidental and so is a management issue. A review is to be conducted of the SANISI annexes to determine if these can be downgraded to NATO UNCLASSIFIED and be permitted to be used as technical input to ISO.

The AHWG on Security is reviewing and maturing concepts of an ISDN security architecture. The AHWG has noted that the *NATO C3 Architecture* (see Section 4 of this appendix) underlines the importance of becoming aware of the security problems associated with an architecture that combines circuit switching with packet switching handling real-time voice and high-bandwidth data. A paper has been developed on security management; it will be condensed and included as Annex D in the NOSA document.

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6 EESP was introduced into SC21/WG1 during the May 1990 meeting in Seoul. EESP has been proposed to the JTC1 as a new work item.

The AHWG has expressed strong support for the WG3 program to demonstrate the proof of concept of the security protocols and architecture. The AHWG on Security has noted concerns that have been expressed that SDNS SP4 is not a suitable candidate from a NOSA point of view, as NOSA does not identify a requirement for security services in the Transport Layer. A recommendation was drafted that WG3 consider the concept of a TCS as in NOSA and SANISI. The TCS services definitions and protocol specification are not yet complete, but will be sufficient to provide the required security services soon.

The AHWG on Security held a meeting of security experts in June 1990 to discuss the TCS service definition and protocol specification. Progress was made on providing the additional technical work required for a detailed design specification for the TCS. This specification will be provided to the SG9 WGs for consideration and, in the case of WG3, possible implementation.

3.4.8 AHWG on MMHS

During the last 3 years, an AHWG on MMHS, reporting to TSGCE SG9 WG2, has been working to have features required by the military incorporated into the MHS defined by international standards bodies. The initial proposals, based on X.400-MHS(84), for an MMHS have been accepted as an Intercept Profile by SG9; it addressed security, confidentiality, integrity, authentication, message stores with access protocols, and directory services. Most of these features have now been incorporated in CCITT X.400-MHS(88). Known as the "Blue Book," MHS(88) was ratified in November 1988.

MMHS will be addressed in a separate Application Layer standard, STANAG 4257; the first working draft of this STANAG was provided to WG2 in February 1990. STANAG 4257 will incorporate four elements that are being developed simultaneously by the AHWG on MMHS: Base Standard [AHWG-MMHS 1990], Rationale [AHWG-MMHS 1990a], an Alpha Profile, and a Beta Profile. The Alpha profile is intended to address strategic and tactical applications where bandwidth limitations are not severe, and the Beta Profile is intended to address tactical applications where bandwidth is severely limited. For the Beta profile, the AHWG on MMHS assumes that bandwidth will be conserved by eliminating all but the most vital services of MHS. These profiles are being written as a "delta" or change to the MHS profile being developed by the European Workshop for Open Systems (EWOS) [EWOS 1990a]. Each MMHS profile will be included in STANAG 4257 as a separately ratifiable annex [WG/1 1990c].

The AHWG-MMHS work has been separated into two sets of functional groups. The first set consist of military messaging services, notification, security, redirection, distribution lists, conversion, ACP 127, and MMHS(84) gateways. The second set will provide directories, message store, physical delivery, management, routing, local services, and PICS. The first draft of the MMHS(88) STANAG [AHWG-MMHS 1990] released in February 1990 addresses the first set of functional groups.

One of the key issues for MMHS is the need for NATO-wide consistency and uniqueness of names and addresses to be in conformance with international standards. WG2 made the following recommendations developed by the AHWG-MMHS to SG9 in May 1990 [WG/2 1990b]:

- Register NATO as a country name with ISO. If this is not acceptable to ISO/CCITT, then NATO should be registered as an Administrative Management Domain within one country (e.g., Belgium).

- Obtain a number for NATO as an Identified Organization in the object identifier structure detailed in ISO 9834.

- Establish a NATO registration authority to register the addresses of end users within NATO management domains (both domain names and the domain-specific part), to register Application process names and Presentation addresses, and also to manage the allocation of numerical subscripts to objects.

In June 1990 the AHWG on MMHS reviewed these recommendations in light of additional information provided by STC. MMHS has now withdrawn the above recommendations and had plans to study the requirements and alternatives in detail at the October 1990 meeting.

The *Intercept Profile for MMHS*, based on MHS(84), has been amended (Issue 2) to include full support for ACP 127 [MMHS 1990]. It was completed in February 1990 and is ready for distribution by SG9. Issue 2 has a new annex (Annex C) on implementation options for the military header extensions. Issue 1 of the profile was accepted as an intercept strategy for the 1989 (Fifth) edition of the *NTIS Transition Strategy* [NATO 1989]; however, depending on choices of interoperability parameters, MMHS implementations based on MHS(88) may not be backwards compatible with MHS(84) implementations (see Section 6.3.2.3).

One area of MMHS not addressed by MHS(88) is support for trusted functionality. Such support may be covered by standards developed by the SDNS security protocols SP3 and SP4 to carry out services associated with trusted functionality. The May 1989 meeting of the AHWG-MMHS was devoted to security and succeeded in developing two functional groups of security services. One of these does not require use of asymmetric encipherment mechanisms, but precludes direct support of nonrepudiation services. These have both been accepted by EWOS. The AHWG-MMHS is seeking guidance from the AHWG on Security to identify suitable encipherment mechanisms to support these services [WG/2 1989]. The AHWG on Security confirms the need for asymmetric cryptographic mechanisms and indicates that such mechanisms must be offered by the Nations for consideration and approval by the appropriate NATO authorities [AHWG-S 1990a].

3.4.9 Lightweight Protocols

The TSGCE AHWG on Restructuring has noted that the work of NIAG SG6 is closely related to the work of TSGCE SG9 on OSI standards. Both groups are interested in the area of lightweight LAN profiles for multi-Service use. The intraship LAN profile being developed by NIAG SG6 is based on France's GAM-T-103, as is the U.S. SAFENET profile and the more general Express Transfer Protocol (XTP) profiles [AHWG-OM 1990].

The Xpress Transfer Protocol (XTP) is a lightweight (providing simplicity and low overhead) transfer protocol with unified internetwork services associated with OSI Layers 3 and 4. XTP conforms to the architecture of the Transfer Layer in RTTS developed in France for use in LANs [GAM 1987]. XTP is designed to support 100 Mbps sustained transfer rates between application programs with growth to 1 Gbps. XTP is designed to provide services for distributed systems not available in ISO TP4 and U.S. DoD TCP; the requirements include supporting remote procedure calls and rapid request/response operations, coordinating multiple processes, and providing transaction-based file access. XTP supports traditional stream services, bulk transport, real-time reliable datagram service, real-time internet gateways, flow/error/rate control, message delivery confirmation,

selective retransmission, message boundary preservation, multiple addressing plans, out-of-band signalling, reliable multicast mechanism, maintenance packets, and multipath capability [Chesson 198; XTP 1989].

XTP has been submitted to ANSI X3.S3 for standardization of its services. Its standardization is also being progressed in the U.S. Navy SAFENET Committee.

4. NATO C3 Master Plan and Architecture

This section reviews the status of the *NATO Consultation, Command and Control (C3) Master Plan* and identifies its relationship to the assessment of standards for ATCCIS. The Master Plan consists of four documents: the Master Plan Overview [NACISC 1989], *TRI-Major NATO Commanders' Command and Control (C2) Plan* [NACISAC 1989a], *Political Consultation and NATO Civil Emergency Planning (PCNCEP) CIS Plan* [NACISA 1989b], *and the NATO C3 Architecture* [NACISA 1989; NACISA 1989a; NACISA 1989b; NACISA 1989c; NACISA 1989d]. The *NATO C3 Architecture* consists of five volumes. The two most relevant to the ATCCIS Architecture are Volume 3, *Information System Subsystem,* and Volume 4, *Communications Subsystem.* Much of the material of Volume 3 was drawn from the ATCCIS architecture. The standards annex to Volume 3 is an early draft of WP 25.

The *NATO C3 Master Plan* was formally considered at the January 1990 plenary of TSGCE. TSGCE prepared a statement, to be submitted in February 1990, to the Conference of National Armaments Directors (CNAD) that endorsed the *NATO C3 Master Plan* with the following caveats [AC/302 1990]:

- The *NATO C3 Master Plan* presents a significant first step towards development of a sound investment strategy for major improvements in NATO C3.
- However, the TSGCE does not consider the *NATO C3 Architecture* to be sufficiently mature to warrant its endorsement as part of the overall Plan and requests that the CNAD invite the NACISC to decouple the Consolidated Architecture (Volume 1) when submitting the Plan for approval to the North Atlantic Council Defence Planning Committee.
- Nations agreed to pursue and resolve many minor issues in the appropriate forums.

5. Standards for NATO CCIS Initiatives

Existing and emerging ACCISs are designed to provide command and control information support for NATO and national systems. The ACE ACCIS will provide the higher-echelon support (i.e., at echelons above corps) for the military forces operating in the European region of NATO. ATCCIS will provide support for land combat tactical units, and the Air Command and Control System (ACCS) will support the air operations. The NATO Maritime Operational Intelligence Support (NMOS) and the Battlefield Information Collection and Exploitation System (BICES) will provide intelligence support. Other ACE ACCIS-related projects include the Standard Automated Message Interface for NATO's ACCISs (STAMINA), the Status Control Alerting and Reporting System II (SCARS II), and the Nuclear Planning System (NPS).

The following sections of this appendix examine the standards specified by near-term NATO and multilateral interoperability demonstration and development efforts in ATCCIS (Section 5.1), ACE ACCIS (Section 5.2), ACCS (Section 5.3), BICES and NMOS (Section 5.4), the Quadrilateral Interoperability Program (Section 5.5), and STAMINA (Section 5.6). Military features required by NATO are addressed. In addition, these sections address some of the issues associated with evolving from near-term systems through the use of standards. Profiles of standards that are to be used in transition implementations for several of the NATO projects are also presented.[7]

5.1 ATCCIS (Land Warfare, Corps and Below)

ATCCIS is a study sponsored by SHAPE for the interoperability of CCISs in the Year 2000 and beyond. ATCCIS completed its five-year Phase II study in October 1990. The final report for ATCCIS Phase II is ATCCIS Working Paper (WP) 39 (24 October 1990). The technical standards applicable to ATCCIS are addressed in WP 25 (August 1990). Most of the data on technical standards in this assessment of standards for WAM are based on the results of WP 25. In addition, the standards paper published in the 1989 draft *NATO C3 Architecture* was an early edition of ATCCIS WP 25.

To satisfy the primary purpose of attaining interoperability, ATCCIS is required to satisfy four principal objectives:

a. To formulate common requirements for the use of battlefield information
b. To ensure that all international and multinational users of critical battlefield information can exchange that information on a basis that is mutually agreeable
c. To exchange information so that it conveys the same meaning and understanding to source and recipient alike
d. To define a technical architecture capable of accomplishing the necessary exchanges and transactions.

The principal findings of the Phase II study were the following:

- There is more than 80% commonality in the key command and control (C2) tasks performed at corps level and below, despite the fact that the organization and structure of command posts (CPs) utilized by the four Nations differ significantly.

- The four Nations can directly correlate those specific C2 processes performed in, and the information exchange requirements (IERs) pertaining to, their respective corps, division, and brigade CPs with a harmonized set of ATCCIS C2 processes and sets of ATCCIS IERs.

- Current C2-related operational standards prescribed for use by NATO and the Nations are often conflicting, inadequately defined, and ill-suited for international exchange of information in either a manual or an Automatic Data Processing (ADP)-supported command, control and information system (CCIS) environment.

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7 Profiles differ from stacks in that a profile usually consists of several stacks of standards and further that profiles are usually recommended for a certain transition strategy or a specific implementation. In some cases, profiles specify options to be used.

- A NATO-wide data management policy is required.
- A technical architecture for an ATCCIS can be defined by using international commercial (nonproprietary) standards supplemented, where necessary, with military enhancements or standards.
- The analysis has concluded that an ATCCIS-conformant system must be a transaction processing system with a partitioned, partially replicated database.
- The concept for the ATCCIS architecture is consistent with that for the *NATO C3 Architecture*.
- Operational and technical standards necessary for national implementation are still immature; a program definition phase is required.

5.2 ACE ACCIS (Land Warfare, Echelons Above Corps)

The initial phase of development of a standardized and interoperable ACE ACCIS was the Architectural Design Study. The next phase is System Design and Integration, for which a major support contract has been awarded by the NATO Communications and Information Systems Agency (NACISA). Work on the System Design and Integration Contract (SD&IC) began in early 1989 and is expected to be completed in 1991.

ACE ACCIS will provide automation support for NATO headquarters at echelons above corps (e.g., PSCs). The SD&IC will provide about 450 person-months of effort from January 1989 to April 1991. Among the SD&IC objectives are the ACE-wide issues of interoperability and standards, and the contractor will be identifying the functions to be supported at each interface. NACISA intends to ensure that the project complies with NATO standards and the *NTIS Transition Strategy*. STAMINA has been mandated for the SD&IC effort. The planned products include [Briggs 1988]:

- Logical models of the existing system and a new system
- Generic description of the new system, together with a complete functional design that "embodies technical standards"
- Recommended implementation options (Aug 90) and transition plan
- Procurement specifications to support procurements in the Central Region and the Southern Region in the 1990s
- Automated support for configuration management.

NACISA expects that the products of the SD&IC effort will become standards for NATO.

5.3 Air Command and Control System (ACCS)

The Air Command and Control System (ACCS) is a system to support air operations planning, tasking, and execution throughout ACE from Major NATO Command

(MNC) level to combat unit level.[8] ACCS will interface with the ACE ACCIS at the Primary Subordinate Command (PSC) and will concentrate new development at the PSC and below. ACCS will progressively replace a current federation of individual systems that support ACCS functions to varying degrees.[9] At the PSC level and above, ACCS functions will be performed by the ACCIS of each Command.

Development of ACCS, which integrates offensive and defensive air command and control functions, has been underway for several years. Implementation is planned to begin in the early 1990s. In April 1989, the ACCS team completed the *ACCS Master Plan*. The ACCS team was replaced by the ACCS Interim Management Agency, and the new group will conduct a system definition phase. The goal is preparation of system specifications and technical estimates for a Type B cost specification for and procurement by Slice 42 (1991).

The interoperability concept for ACCS is discussed in Volume IV, *Generic Portion of the Overall ACCS Design*, of the *ACCS Master Plan*, [ACCST 1986], and in the *Supporting Document on Organization Components* [ACCST 1988]. ACCS interoperability is planned through exchange of information through commonly agreed to information definitions, formats, and technical standards. Where possible, the standards to be used are those developed by the Military Agency for Standardization (MAS), ADSIA, and TSGCE SG9. Specifically, ACCS will be based on the OSI Reference Model as specified in STANAG 4250 (NATO Interoperability Model), the OSI services for Layers 1 through 7 as specified in STANAGs 4251-4259, and the OSI protocols for Layers 1 through 7 as specified in STANAGs 4161-4268. In addition to the ISO Reference Model standards, the NATO Common Interface Standards will be used. TSGCE SG9 is responsible for the OSI technical standards, and ADSIA is responsible for the procedural standards. Operational interoperability standards will be based, in part, on Allied Tactical Publications (ATPs). In addition, the CCITT ISDN network architecture is being evaluated for full integration of communication services in ACCS.

The ACCS communications concept is to integrate the various NATO and national dedicated communications systems currently used to support air operations into a common user data and voice network. ACCS would be hosted on the existing and planned communications without ACCS-unique communications means. Initially a packet switched data communication overlay would be added to the circuit-switched voice system. This would evolve into common user area ISDNs within each NATO region. Continued support for both character-oriented and bit-oriented messages is required. Specifically, use of tactical data link standards such as Link 4, Link 6, Link 11, Interim JTIDS Message Standard (IJMS), and Link 16 would continue through the foreseeable future.

ACCS has been reviewing technical information exchange standards and requirements, including the need to replace Link 1 for data exchange[10] in the ground

8 The seven ACCS major functional areas are: Force Management (FM), C2 Resource Management (C2RM), Airspace Management (AM), Surveillance (S), Air Mission Control (AMC), Air Traffic Control (ATC), and Information Exchange.

9 The systems include Improved United Kingdom Air Defence Ground Environment (IUKADGE), System de Traitement et de Representation des Informations de Defense Aerienne (STRIDA), German Air Defense Ground Environment (GEADGE), and NATO Airborne Early Warning (NAEW).

10 ADSIA WG4 has been given a Priority One task to develop a Link 1 replacement; ADSIA WG4 has asked TSGCE(SG9) to look at media-independent protocols for such a concept.

environment. The current approach is to base a new standard on STANAG 5516 (J-Series messages) and to develop (within ADSIA WG4) new or modified messages to fulfill specific ACCS Information Exchange Requirements. ACCS plans to use a military version of X.25 for packet-switched systems and for transfer over dedicated circuits and through circuit switches. Variable packet lengths are desired. CSMA/CD and token ring LANs are being considered for ADP systems. As in ATCCIS, the ACCS database concept is partitioned and partially replicated. An ACCS-wide data dictionary is planned. Analysis has included an STC investigation on the applicability of ASN.1 and its relation to the syntax of STANAG 5500 (FORMETS). There is a concern as to whether use of FORMETS would permit achieving the full benefit of the OSI model.

The following considerations in ACCS indicate some elements of the technical approach for achieving interoperability:

- ACCS interfaces will be required to the following generic external agencies/systems:
  - NATO intelligence systems (e.g., BICES, NMOS)
  - NATO army headquarters
  - NATO land-based maritime headquarters
  - NATO maritime forces afloat
  - National headquarters, intelligence, army headquarters, maritime headquarters, territorial commands, meteorological services, civilian air traffic control, and local authorities.
- Requirements have been identified for free text traffic (electronic mail), graphics, and facsimile transmission services. Video transmission is a potential long-term requirement for ACCS, but it has been excluded from consideration for the current ACCS planning time frame (1990s).
- Two ADSIA standardization documents have been considered important for ACCS in the area of formatted messages:
  - ADatP-3/STANAG 5500, containing a catalog of character-oriented formatted messages
  - Common Information Exchange Glossary (CIEG), containing terms and definitions applicable to the development of both bit- and character-oriented procedural standards.
- ACCS requires an electronic mail service. The planned standard is the Military Message Handling System, based on CCITT X.400 (see Section 3.4.8 of this appendix).
- ACCS further requires automated interactions between databases (e.g., updates) that could be event driven. The FTAM standard has been recommended for consideration for ACCS use, particularly for bulk update of databases.
- The functions (e.g., syntax and formatting rules) of ASN.1 and the associated Basic Encoding Rules (BER) were recognized by the ACCS Team as potentially richer and offering greater scope than NATO Message Text Formatting System (FORMETS) functions of ADatP-3/STANAG 5500. Large investments in FORMETS are being made in operational systems, and NATO

interoperability continues to be based on FORMETS and ADatP-3. Eventually, however, FORMETS could be replaced by ISO standards for automated data exchange to make better use of the functionality of the OSI model and the richness of ISO standards. There are potential problems in ensuring interoperability between systems using FORMETS and systems using ISO standards. Investigation is needed on whether the use of an information structure based on ADatP-3 message contents is a sufficient basis for achieving backwards interoperability with FORMETS systems.

- ACCS anticipates the use of gateways for data forwarding (message standard translation), trusted secure interfaces between cooperating ADPde adequate flow control under stress conditions. Limited use of a connectionless service may also be required.

5.4 Intelligence Systems, BICES, and NMOS

5.4.1 Battlefield Information Collection and Exploitation Systems (BICES)

BICES will provide intelligence support for the ACE ACCIS, including the land-surface picture for NATO. BICES is a project under the direction of TSGCE PG7. BICES will consist of three segments, which will utilize either national or NATO intelligence capabilities [NST 1988]:

- Higher national segment includes national capabilities at the MOD-DoD and Theatre Level

- Lower national segment includes national capabilities below NATO PSCs

- The NATO segment of BICES, as the hub of the interconnected systems, will include the NATO capability at the NATO command level (a portion of ACE ACCIS).

The BICES concept will involve integration of national and NATO systems, initial processing, processing/fusion, and user exploitation. The BICES capability will be integrated into the ACE ACCIS. Specifically, the ACE portion of BICES (and NMOS) will go under the SD&IC activity of the ACE ACCIS. Configuration management for BICES will fall under configuration management of ACE ACCIS. User requirements for the ACE segment of BICES are completed [BICES 1988], but the majority of the national annexes have not yet been provided. One national operational capability has been designated as part of BICES, namely the Limited Operational Capability-Europe (LOCE) system developed by the United States.

Among the approaches being considered for BICES are a common database and a data dictionary, whose scope and content are to be determined. NATO OSI standards from ISO and CCITT will be used unless they cannot meet the BICES requirements.

5.4.2 NATO Maritime Operational Intelligence Support (NMOS)

NMOS will also provide intelligence support for the ACE ACCIS. NMOS provides the naval surface and subsurface picture for NATO. NMOS is a joint project under SACLANT, SHAPE, and CINC-CHAN. The only standard identified for NMOS that are not part of the NATO Common Interface Standards (NCIS) are additional

STANAG 5500 (ADatP-3) messages [NMICC 1989]. The Military Committee approved the Tri-MNC concept for NMOS early in 1987 [NATO MC 1987].

5.5 Quadrilateral Interoperability Program

The Quadrilateral Interoperability Program is an initiative of four nations--France, Germany, United Kingdom, and United States--to develop and implement, for the short term, an interface through which the four national ACCISs [respectively Systeme Informatique de Commandement des Forces Terrestres (SICF), Heeres-Fuehrungsinformationssystem fur die rechnergestuetzte Operations-fuehrung in Staeben (HEROS), WAVELL, and Maneuver Control System (MCS)] can interoperate. Software development for the national systems has been completed and an interoperability demonstration was successfully conducted in May 1990 near Ingostadt, Germany [ADSIA 1988a]. Meetings were held in June and July of 1990 to explore options for fielding initiatives based on the Quadrilateral Interoperability Program standards.

The Quadrilateral Tactical Interface Requirements (QTIR) document [QIC 1988] expresses the basic requirements. The Quadrilateral Technical Interface Design Plan (QTIDP) [QIC 1988a] specifies, for the gateway, the technical interface based on the ISO/CCITT seven-layer reference model. The operational requirements specify for information representation the use of formatted messages as described in STANAG 5621 Edition 2 and in accordance with ADatP-3 (STANAG 5500) specifications. The specifications for the common international interface between national gateways are provided in the QTIDP by annexes describing each of the seven layers with options and parameters derived from ISO/CCITT standards [Table K-6] in order to meet the specific military requirements (e.g., naming, addressing, priority, sensitivity, size of messages, and segmenting).

As shown in Table K-6, specifications of the QTIDP for Layers 1 through 5 are in terms of ISO standards. Layers 6 (presentation) is a null layer. Layer 7 specifies message handling functionality based on the CCITT X.400 standards for the subset of service elements provided by the P1 and P2 protocols and the service elements provided by Reliable Transfer Service (RTS), as defined by DIS 9066-2, and integrated with the Association Control Service Element (ACSE, ISO 8649 and ISO 8650) that provide support for other application entities. The Quadrilateral Test and Demonstration Management Plan (QTDMP) [QIC 1988b] specifies a plan for interface testing and interoperability testing before performing the 1990 demonstration. Most of the interoperability parameters are specified by the options, classes, and system parameters selected from ISO/CCITT standards; some of the other interoperability parameters are defined in accordance with military requirements defined for messages in the QTIR.

A preliminary review has shown that all standards, stacks, and options for the Quadrilateral Interoperability Program that are also relevant to ATCCIS have been identified in earlier chapters of this working paper. In addition, a separate analysis [Ford 1987] has been performed that identifies a large number of interoperability parameters and provides their values.

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11 Army Command and Control Information System for the Computer Assisted Conduct of Operations within Staffs (HEROS).

Table K-6. Standards for Quadrilateral Interoperability Program

Layer	References for Standards
7. Application	ISO 8649-1986 (ACSE) ISO 8650-1986 (ACSE) CCITT X.400, X.401, X.408, X.409, X.411, X.420 DIS 9066.1, 9066.2 ((Reliable Transfer) DIS 8824 (ASN.1) DIS 8825 (ASN.1 Basic Encoding Rules) IS 646, IS 6937 (Coded Character Sets)
6. Presentation (Null Layer)	DIS 8822-1985 DIS 8823-1985
5. Session	DIS 8326-1984 DIS 8327-1984
4. Transport	DIS 8072-1984 DIS 8073-1984
3. Network	ISO 8208-1985 (X.25 PLP) DP 8348 (CONS) DP 8472 (Network Convergence Protocol) DIS 8648-1985 (Internal Organization Network Layer) DP 8878-1984 (X.25 CONS) CCITT X.25-1984 STANAG 4214 (Internal Routing) STANAG 5046 (Communications Directory)
2. Data Link	ISO 7776-1985 (HDLC LAPB) DIS 8886-1985 ISO 3309 (HDLC Frame Structure) ISO 4335 (HDLC Procedures)
1. Physical	ISO TR 7477-1985 DIS 8481-1985 ISO/TC97/SC6 N3473 (DP 10022) ISO 4903 CCITT V.3, V.10, V.11, V.28 CCITT X.21, X.24, X.25 CCITT X.27 (EIA/RS-422-A)

5.6 Standard Automated Message Interface for NATO's ACCISs (STAMINA)

This summarizes the results of a review of the specifications for STAMINA [NACISC 1988h]. STAMINA is being developed by an Interface Working Group of NATO Communications and Information Systems Agency (NACISA) to be used as a standard interface for passing information among ACCISs. Initial demonstrations are planned for the Central Region ACCIS and three target systems: the Allied Command Baltic Approaches Command and Control Information System (ACBA CCIS), the Central Region Alternate War Headquarters CCIS (CR AWHQ CCIS), and the Allied Tactical Operations Centre CCIS (ATOC CCIS, also known as the EIFEL Follow-On). STAMINA is planned to be used for such interfaces as [Reed et al. 1990]:

- Central Region (CR) ACCIS to UKAIR ACCIS and to EIFEL (ATOC)
- SHAPE and CR Primary War Headquarters (HQ) to SHAPE and CR Mobile Alternative HQ

- ACBA (Baltic Approaches) ACCIS to CR ACCIS and to EIFEL (ATOC).
- Various interfaces at SHAPE HQ.

STAMINA consists of two separate transport profiles and an X.400-oriented application profile. The transport profiles support (1) X.25 packet switched networks for use in CR ACE and (2) permanent analog circuits for point-to-point interfaces using dedicated analog circuits. A third transport profile, switched analog circuits for use with the NATO IVSN analog voice network, has recently been deleted, as there has been no interest shown in implementing this aspect of STAMINA.

The entire STAMINA profile has been adopted by TSGCE SG9 as an intercept profile for the *NTIS Transition Strategy* [Chair 1989]. In the future STAMINA could be considered as several NATO standardized profiles.

Requirements for the Quadrilateral Interoperability Program and STAMINA overlap, but it is not clear at this time if they will converge. Generally, STAMINA attempts to provide military features (e.g., four levels of precedence and NATO classifications) as "extensions" in Layer 7.[12] Further, STAMINA provides three transport protocols (using Class 0 and Class 2), whereas the QTIDP provides just one (using Class 2) [Reed 1988].

5.6.1 STAMINA Application Profile

The STAMINA application profile for message handling is a modification of CCITT X.400(MHS)-1984 in which 18 military features were added. These features are identified in Table K-7. STAMINA messages are free text and text formatted according to the ADatP-3 specification [ADaT P-3 1986a].

The application profile has two types of user access:

- Private Message Handling Service (MHS) Access: UA and MTA, PRMD to PRMD, A/3211 (based[13] on CCITT X.400-1984 and ISO 8327)
- Military Private MHS Access: UA and MTA, PRMD to PRMD, A/3211(M) (based on CCITT X.400-1984, ISO 8327, ACP 117, and ACP 127).

The A/3211 application profile is the X.400 MHS, in which the Application Layer (Layer 7) has three sublayers: User Agent Layer defined by X.420, Message Transfer Layer defined by X.411, and Reliable Transfer Server defined by X.410. The A/3211 Presentation Layer (Layer 6) is defined by ISO 8823 (based on X.410), and the Session Layer (Layer 5) is defined by ISO 8327 (based on X.410).

STAMINA applications profile and the Quadrilateral Profile (QP) are both military versions of CCITT X.400(MHS)-1984. The QP is being developed and used by four command and control system programs in France, Germany, United Kingdom, and United

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12 STAMINA leaves the commercial P1 and P2 sublayers unmodified and defines new service elements as extensions to P2; the QTIDP redefines both P1 and P2.

13 STAMINA Version 3.0 [Rose 1990] also cites "ISO 8322" for T/3211 and T/3211(M), but this standard does not exist.

States. The QP has a single transport profile based on X.25. To understand some of the essential differences between STAMINA and QP, note that Layer 7 of X.400-1984 consists of the User Agent (UA), the Message Transfer Agent (MTA), and the Reliable Transfer Agent (RTA). The RTA serves as the liaison with the Session Layer protocols (in X.400 1984, the Presentation Layer is a null layer; i.e., there is no layer 6, so Layer 7 liaises directly with Layer 5). Both the UA and MTA use peer (e.g., UA-to-UA) protocols to communicate to distant UAs and MTAs. The peer protocol for the UA is the Interpersonal Messaging Protocol (P2), while the peer protocol for MTA-to-MTA communication is the Message Transfer Protocol (P1). Thus, P1 defines the relaying of messages among MTAs, while P2 defines the service elements of the interpersonal messages exchanged by UAs. The STAMINA profile provides military features by extending P2 (using a "superset" approach), permitting these features to be mapped into similar commercial features in the P1 protocol without affecting lower layer protocols, whereas the QP changed both P1 and P2 in such a way that the changes affected services in lower protocol layers as well.

5.6.2 STAMINA Transport Profiles

STAMINA includes selection of CCITT and ISO standards--along with allowable options and parameters--necessary to attain interoperability among the end systems. STAMINA is based on profiles defined in the SPAG User's Guide [SPAG 1987]. The STAMINA transport profiles are:

- Permanent Telephonic Circuit Providing Connection-Oriented Network Service, T/21(M)
- Telephonic Switched Circuits Providing Connection-Oriented Network Service, T/22(M)
- Permanent Access to Packet Switched Data Network (PSDN), OSI Connection-Mode Services, T/312(M)

Table K-8 identifies the standards specified for the STAMINA transport profiles. The current standard for STAMINA is Version 4.0, April 1990 [STAMINA 1990].

5.6.3 STAMINA Development Activities

One current activity is addressing the need to add functionality required to support relays between X.400 and ACP-127 message domains, as recommended by TSGCE and recommended by the *NATO C3 Architecture* and the *NATO C3 Master Plan*. In addition, STAMINA is building a database of the interoperability parameters (e.g., speeds for communications lines) chosen by implementors of STAMINA specifications. Some parameters must be identical for interoperability and others must fall within certain ranges. The database will also track some parameters that do not affect interoperability. STAMINA is also planning to develop a conformance test suite and a file transfer functional profile (based on FTAM). A new transport profile is being developed for digital circuit switch connections for communications supporting the SHAPE and CR Mobile Alternate War HQ. The current STAMINA application profile will be implemented in the STC testbed. Finally, STAMINA has an initiative, not yet under contract, for an Automated Message Processing System (AMPS), intended to automate message processing at various ACE commands.

Table K-7. Military, Features Added to the STAMINA Specification

	Military Feature	Description
1.	Extended Authorization Info	Date and time officially authorized
2.	Subject Indicator Code	Eight subject codes for distribution information
3.	Primary Precedence	Grades of delivery (e.g., urgent, normal) for primary recipient
4.	Copy Precedence	Grades of delivery for copy recipient
5.	Security Classification	Five classifications (e.g., NATO UNCLASSIFIED)
6.	Security Category	E.g., ATOMAL, EYES ONLY
7.	Originator Identifier	Originating organizational unit message reference
8.	Address List Indication	Address list type and identifier; on origination conveys multi-destination delivery; on receipt, forwarding action
9.	Clear Indication	Transmitted without any security classification
10.	Codress Message Indicator	Indicates a codress encrypted message
11.	Corrections	Corrections are required in body of text
11.	Exempted Address	Exempted name(s) from accompanying address list
13.	Handling Instructions	Handling instructions accompany the message
14.	Message Instructions	Message instructions accompany the message
15.	Message Type	Distinguish between normal and exercise traffic
16.	Other Recipient Indicator	Identifies other recipient(s) also intended to receive message
17.	Pilot Forwarded	Used in forwarding a message
18.	Security Policy Indentifier	Identifies a security policy

Table K-8. Standards for STAMINA Transport Profiles

Layer	Transport Profiles T/21(M)	T/22(M) T/312(M)	T/312,
4. Transport	ISO 8072 ISO 8073[a]	ISO 8072 ISO 8073[a]	ISO 8072 ISO 8073[a]
3. Network	ISO 8348 ISO 8208 ISO 8878 STANAG 4214 STANAG 5046	ISO 8348 ISO 8208 ISO 8878 STANAG 4214 STANAG 5046 CCITT V.25 CCITT V.25bis	ISO 8348 ISO 8208 ISO 8878 STANAG 4214 STANAG 5046
2. Data Link	ISO 7776[b]	ISO 7776[b] CCITT V.25 CCITT V.25bis	ISO 7776[b]
1. Physical	CCITT V.24 CCITT V.11 ISO 2110 ISO 4902 MIL-STD-188C	CCITT V.24 CCITT V.11 ISO 2110 CCITT V.25 CCITT V.25bis MIL-STD-188C	CCITT X.21 CCITT V.11 ISO 2110 ISO 4902 ISO 4903 MIL-STD-188C CCITT X.21bis

[a] Class 0 (Simple) and Class 2 (Multiplexing) are mandatory; Class 4 (Error Detection and Recovery) is optional.

[b] Options 2 and 8 of ISO 7809 (Balanced Asynchronous Class) are mandatory; Option 10 may be included under bilateral agreement.

The Configuration Management Board (CMB) for STAMINA has agreed [US 1988] to add the additional military features to the X.400 specification, making it identical to MMHS(84). The new Version 4.0 of STAMINA should be reviewed for such compliance. The CMB has decided to omit one part of STAMINA, the Transport Profile for Analog Circuit Switch, which was seen as high risk and for which no interest has been expressed from implementors. A consultant contract is planned to develop a conformance test suite for STAMINA, to be delivered at the end of 1990. An FTAM application profile is to be developed; the effort is now in a pre-contract award stage and a product is expected at the end of 1990. There are plans to develop another transport profile for STAMINA for digital circuit switched communications. NACISA is interested in studying the compatibility of STAMINA with the 1988 standards, with an orientation to migrate toward a 1988 base or, alternatively, define an interface module between the 1984- and 1988-based systems.

Some STAMINA parameters are left to be determined by the implementors of an interface, and some of these must be the same on both ends of the interface. NACISA has developed a database in which to record the parameters used on all STAMINA implementations. NACISA has begun to develop a new project called the Automatic Message Processing System (AMPS). It appears at this early stage that it will have two aims [NACISA 1990]:

- To provide individual ACE HQs with automated processing capability internal to each HQ for generation of outgoing messages and to provide the processing of incoming messages. Initially, the messages will be transmitted via the existing TARE system using TARE-unique protocols. Where possible, the internal processing will be based on X.400 oriented systems.

- To use the AMPS at each HQ as the platform for the eventual replacement of the TARE with an X.400 oriented network.

AMPS is expected to be based on X.400(88) rather than on STAMINA or MMHS(84), and NACISA plans to work closely with SG9 for the standards.

An ACE ACCIS Integrated Testbed is planned for the SD&IC efforts and the BICES Pilot Study (BPS) efforts, with NACISA serving as the host nation and STC providing scientific expertise and the home of one of the testbed nodes. SHAPE will provide personnel to implement STAMINA on this testbed, as well as other protocols that may emerge from the SD&IC or BPS.

6. U.S. DoD Initiatives for Use of Open Systems

6.1 DoD Protocol Suite

Figure K-1 shows the DoD protocol suite.[14] The upper layer protocols providing user functionality support file transfer [File Transfer Protocol (FTP),[15] MIL-STD-1780];

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[14] The figures and information for this section and the following sections on U.S. GOSIP and proposed mixed stacks for Army CCISs is taken from *Use of OSI Protocols for U.S. Army Tactical Command and Control Applications*, Richard Nieporent and Brajesh Mishra, The Mitre Corporation, Proceedings of the SHAPE Technical Centre Military OSI Symposium, 6-8 June 1990, NATO UNCLASSIFIED.

[15] FTP provides a simple application for transfer of ASCII, EBCDIC, and binary files.

electronic mail [Simple Mail Transfer Protocol (SMTP), MIL-STD-1781]; and remote system access [TELNET Protocol,[16] MIL-STD-1782]. The middle layers provide a reliable host-to-host transport protocol [Transmission Control Protocol (TCP) MIL-STD-1778] on top of a connectionless (CL) internetworking protocol [Internet Protocol (IP), MIL-STD-1777].

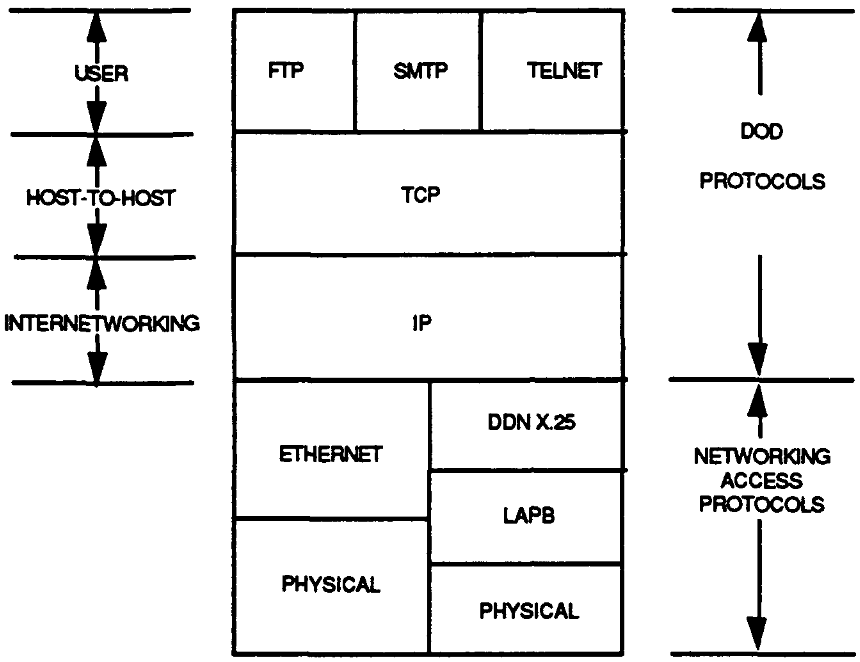

Figure K-1. DoD Protocol Suite

No lower layer protocols are specified in the DoD protocol suite--it uses whatever protocols are required to access the network to which it is attached. Thus, for example, the DoD protocol suite uses the Ethernet™ (CSMA/CD Media Access Control for a coaxial cable 10-Mbps LAN) protocol to operate a local area network and the DDN implementation[17] of the CCITT X.25 protocol (X.25 Packet Level Protocol, ISO 8208) and the HDLC LAPB (ISO 7776) procedures to operate over a wide area packet switching network. Although DoD protocols are not international standards, they have become a de facto open standard in the United States--almost every vendor provides the DoD protocols in their version of the UNIX operating system. The DoD protocols are also included in the ATCCS Common Hardware and Software (CHS) procurement and are specified for use over the CHS IEEE 802.3 (ISO 8802.3) tactical LAN. Finally, the DoD protocols are used by the MSE packet switched network (PSN).

The DoD protocol suite has two drawbacks for its use in tactical CCISs:

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[16] TELNET Protocol provides a simple scroll-mode terminal capability.

[17] The DDN implementation of X.25 was provided by Bolt Beranek and Newman. It is also planned for use in the Mobile Subscriber Equipment (MSE) for Army area communications.

- The DoD protocol suite is not U.S. GOSIP compliant. It would be necessary for implementations of the DoD Protocols to undergo an expensive and time-consuming transition to satisfy the GOSIP mandate. In particular, the battlefield functional area (BFA) applications will have to be modified to use the functionality of the GOSIP protocols.

- GOSIP Application Layer protocols provide more functionality than the DoD protocols. Moreover, more effort is now being committed by the nations for the OSI protocols than by the United States in the DoD arena. As new OSI protocols are developed that meet tactical communication requirements, they are expected to be incorporated in GOSIP. Thus, future versions of U.S. GOSIP are expected to provide considerably more functionality than the DoD protocol suite.

6.2 DoD Transition to GOSIP

The U.S. DoD has already adopted OSI protocols as a full co-standard with DoD protocols, specifically for message handling and file transfer (MIL-STDs 1777, 1778, 1780, and 1781). In 1990, 2 years after U.S. GOSIP was approved as a federal standard, "OSI protocols will become the sole mandatory interoperable protocol suite" [ASD(C3I) 1987]. The Defense Communications Agency (DCA) has been named as the DoD Executive Agent for Data Communications Protocol Standards, and in June 1988 this agency promulgated an OSI implementation strategy [DCA 1988]. The Services and Agencies are now developing transition plans to comply with this strategy.

6.3 Packet Switching for DDN

The U.S. Defense Communications Agency has implemented an X.25 packet-switched protocol for the Defense Data Network (DDN). This protocol includes the use of the U.S. DoD-unique protocols for Layers 3 and 4, namely the Internet Protocol (IP) and the Transmission Control Protocol (TCP). DDN supports over 50,000 users of a DoD-unique electronic mail (E-Mail). DDN contains a set of physically, procedurally, and cryptographically secured packet switching segments for classified E-Mail in the Defense Integrated Secure Network (DISNET) (e.g., DISNET-1, DISNET-2, DISNET-3). There are additional segments for unclassified E-Mail [e.g., Military Network (MILNET) and Advanced Research Projects Agency Network (ARPANET)]. Local area networks (LANs) are connected to the DDN by gateways or hosts using the DoD IP.

6.4 Defense Message System (DMS)--Upgrades for DDN

The United States has initiated [DCA 1989c; C3 1989] a project called the Defense Message System (DMS) that will eventually integrate DDN with the Automatic Digital Network (AUTODIN). DMS will phase in [DCA 1988a] such protocols and services as U.S. GOSIP, CCITT X.400 Message Handling System, High-Level Data Link Control (HDLC) for subscribers, new asynchronous protocol(s) with reliable transfer for subscribers, and CCITT X.500 Directory Services. TCP/IP protocols will be phased out. Initially (Phase I) a U.S. DoD-unique security program called BLACKER will be implemented at the host-to-host level, which will ultimately result in an integrated DISNET. Later (1993) DDN will consist of MILNET (unclassified) segments and DISNET (classified) segments connected by BLACKER-protected gateways.

6.5 U.S. Army Initiatives

The U.S. Army has a number of initiatives underway that address tactical implementations of OSI standards. The initiatives are under the direction of the Interoperability and Standards Directorate of the Communications-Electronics Command. The Army has an initiative to evaluate OSI protocols (including possible enhancements) in the newly developed Single-Channel Ground/Air Radio System (SINCGARS) combat net radio (VHF-FM). Specifically, the Army is examining options to provide an automatic voice/data contention resolution protocol at the Medium Access Control (MAC) sublayer of the data link layer (Layer 2). Some investigation of a forward error correcting Layer 2 protocol is also ongoing. In addition, an OSI profile is being developed for a local area network (T.LAN). Further, the Army has procured with its Common Hardware and Software (CHS) nondevelopmental item (NDI) program a number of commercial OSI implementations, including ISO 8802.2 and 8802.3 for the local area network (TCP/IP and other DoD protocols will be used initially at layers above Layer 2). CHS has CCITT X.25 switched protocols for wide area network interfaces (these also are used in conjunction with TCP/IP). Finally, the CHS has a standard graphics interface and plans in the next procurement phase to obtain, if possible, a POSIX-conformant operating system [CECOM 1989].

6.6 Mixed Protocol Stacks for Future Army CCISs

The U.S. Army is developing an automated Army Tactical Command and Control System (ATCCS) for the tactical battlefield. Communications connectivity for the ATCCS will be provided by the U.S. Army's local and wide area tactical communications networks. A protocol suite must be selected for the ATCCS that can interface to these tactical networks and support a wide range of tactical communications applications. A mixed protocol suite, consisting of OSI upper layer protocols operating over the U.S. DoD transport and internetworking protocols (TCP/IP), has been recommended to support the required ATCCS functionality and interoperability and provide a direct migration path to U.S. GOSIP and the NATO militarized OSI protocols.

Figure K-2 shows a proposed mixed suite of protocols for ATCCS. The upper three layers consists of the GOSIP Session, Presentation, and Application Layers. The same FTAM, X.400, and VTP Application Layer protocols are specified as in GOSIP. The middle protocol layers are the same as in the DoD protocol suite: TCP and IP. Also, as in the DoD protocol suite, the lower layer protocols (Physical, Data Link, and Network Layers) are unspecified.

A Convergence Protocol [Request for Comment (RFC) 1006, *ISO Transport Service on Top of the TCP*, Version 3, 1987] is needed to interface the GOSIP upper layer protocols to the DoD internetworking protocols. The Convergence Protocol provides OSI Transport Class 0 (TP0) along with a packetization protocol.[18] This protocol is commercially available in Version 6.0 of the ISO Development Environment (ISODE).

[18] Since TCP is a stream-oriented protocol and TP0 is a block-oriented protocol, the packetization protocol is needed to preserve the OSI packet boundaries.

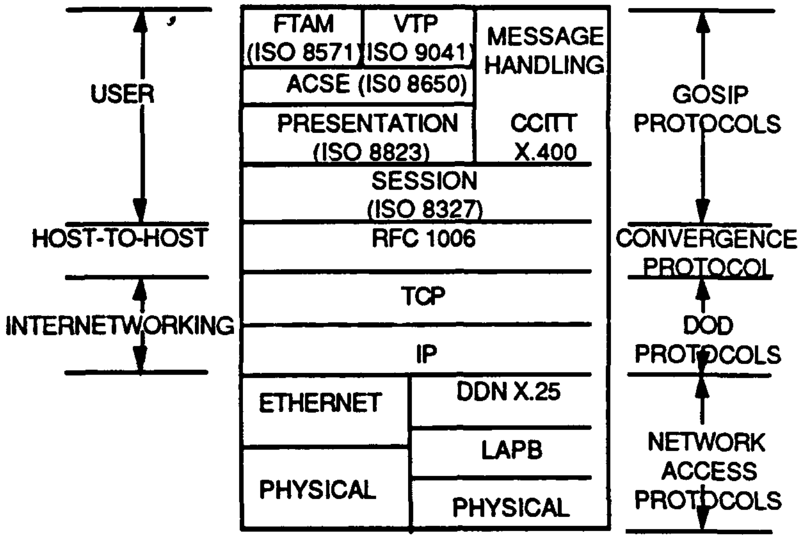

Figure K-2. Proposed Mixed Protocol Suite

The mixed protocol suite has the increased functionality of the GOSIP Application Layer protocols, without sacrificing compatibility with the MSE PSN. No changes will be necessary in BFA applications when ATCCS transitions to GOSIP, since they would already use the GOSIP Application Layer protocols [Nieporent et al. 19990].

6.7 U.S. Marine Corps Initiatives

The Marine Corps has adopted a Technical Interface Design Plan (TIDP) for Marine Tactical Systems (MTS) [Marine 1987] that mandates the use of bit-oriented messages and two functional profiles for protocols in all its command and control systems. One profile for broadcast mode is designed to be used in combat net radio. It has been implemented in the AN/PSC-2 Digital Communications Terminal (DCT). The second profile of protocols is for switched mode and was developed from the Joint Tactical Communications Program (TRI-TAC) Interface Control Documents for the Unit Level Tactical Data Switch (ULTDS). The Marine Corps now plans to incorporate its packet switching protocol into a packet switch overlay of its Unit Level Circuit Switch, rather than having a separate ULTDS. The switched profile is also being implemented with the Tactical Air Operations Module (TAOM) and a developmental system for air operations--Advanced Tactical Air Command Central (ATACC). Although not fully OSI conformant, the two MTS profiles are based on several OSI standards (ISO 3309, ISO 7809, and ISO 4335). The Marine Corps' approach to data communications standards and profiles follows the OSI seven-layer model and incorporates military features not covered within the ISO standards.

6.8 Example Theater-Level CCIS

The U.S Army in Europe (USAREUR) has fielded a maneuver control system called the USAREUR Tactical Command and Control System (UTACCS). UTACCS supports USAREUR Headquarter's staffs at echelons above corps. The UTACCS host provides TELNET, FTP, and SMTP Internet applications over TCP/IP. The UTACCS communications protocols also include TELNET and TCP/IP over X.25 for use as a

gateway to packet switched digital wide area networks. UTACCS includes support for a remote procedure call [Blankertz 1990].

6.9 Standards for Simulations

The primary DoD system for simulations is SIMNET, an advanced research program for a large-scale network of interactive combat simulators. SIMNET is designed to provide a joint, combined arms environment with a complete range of command and control and combat service support elements essential to military operations. SIMNET incorporates such technologies as high-speed processors, parallel and distributed multiprocessing, local area and wide area networking, hybrid depth buffer graphics, special effects technology, and unique fabrication techniques. SIMNET uses the OSI Reference Model to describe its architectural framework for the communications protocols, but the SIMNET framework is not, in fact, compliant with the OSI Reference Model. The SIMNET Database Interchange standards include ASN.1 and ISO 8802.3. SIMNET uses the uniquely defined simulation protocol, association protocol, datagram protocol, and transaction protocol. The association protocol provides a composite of services from the Transport Layer, Session Layer, and Applications Layer (no Presentation Layer Services are stated as required, but ASN.1 is used). The datagram protocol supports broadcasting and multicasting. SIMNET refers to a standard network service, but the only OSI standard cited in the SIMNET specifications for this service is ISO 8802.3 [Lang et al 1989; BBN 1989].

7. Civil Initiatives for Use of Open Systems

Recommendations by non-profit consortia for use of open systems standards are discussed in Chapter 3. Many OSI-based products have become available, some strictly conformant to the standards (with no extensions) and some conformant with extensions. An excellent survey of OSI products available in the United States and Europe is the Product/Vendor/Supplier Survey developed by CCTA in the United Kingdom (4 volumes); the current edition is April 1990 and another edition was planned for April 1991. This surveys the products of 20 vendors worldwide. The volumes are *Introduction, Planning Guide, Company Survey,* and *Product Survey.*

Figure K-3 shows the U.S. GOSIP protocol suite as it appears in Version 2. The applications supported are the same as the DoD protocols: file transfer (FTAM, ISO 8571), electronic mail (MHS, CCITT X.400-series 1984 recommendations;[19] and MOTIS, ISO 10021 and 9066), and the Virtual Terminal Protocol (VT, ISO 9040 and 9041). Also, like the DoD protocol suite, a transport protocol (Transport Class 4, ISO 8073) is specified that will provide reliable host-to-host communications, and a CL network protocol (CLNP, ISO 8473) is specified for internetworking. Unlike the DoD protocols, U.S. GOSIP provides for the Layer 7 Association Control Service Element (ACSE, ISO 8650), connection-oriented protocols for the Presentation Layer (ISO 8823, Layer 6), and connection-oriented protocols for the Session Layer (ISO 8327, Layer 5).

Also, unlike the DoD protocol suite, GOSIP explicitly specifies a number of network access protocols, including IEEE 802 (Logical Link Control, ISO 8802.2;

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[19] U.S. GOSIP 1.0 and 2.0 mandate use of X.400(MHS)-1984. U.S. GOSIP 3.0 is expected to require X.400(MHS)-1988.

CSMA/CD, ISO 8802.3; Token Bus, ISO 8802.4; and Token Ring, ISO 8802.5) for communications over a LAN and the X.25 protocol for wide area network interfaces.

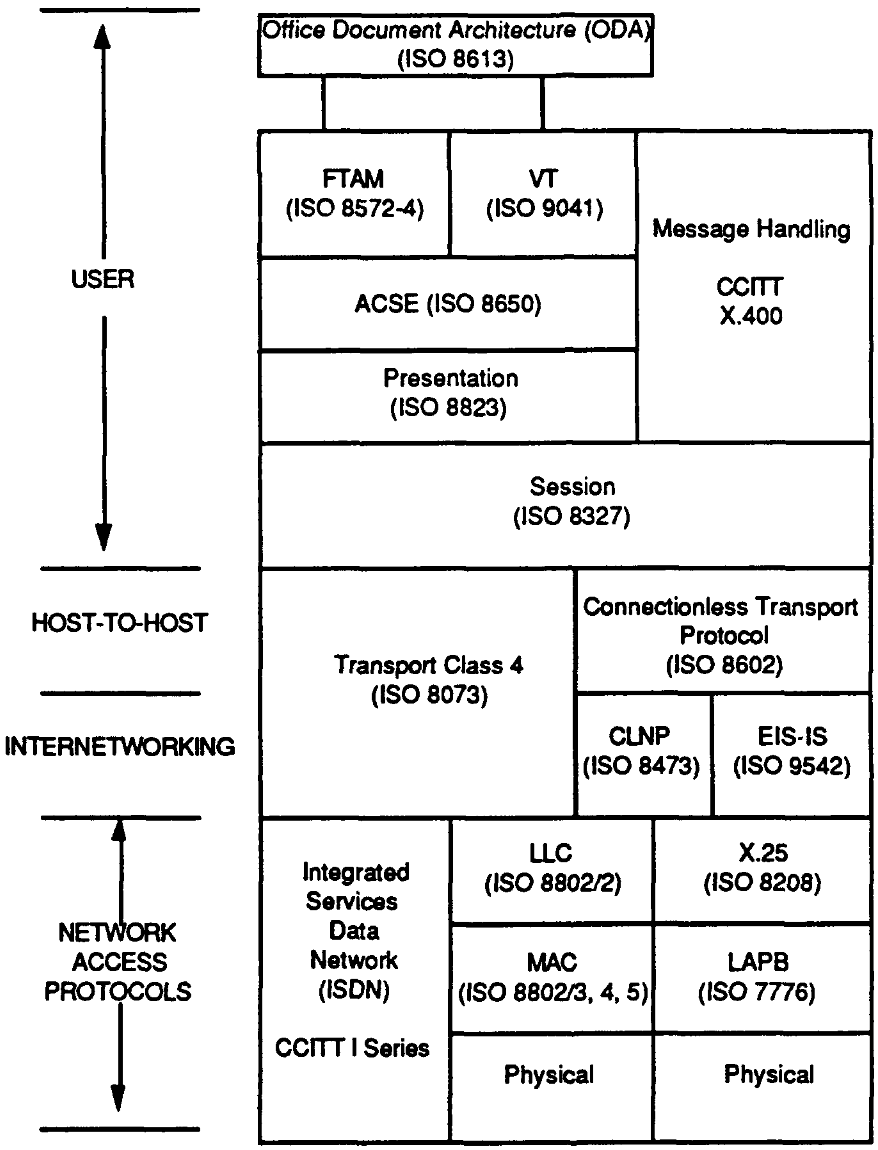

Figure K-3. U.S. GOSIP Protocol Suite, Version 2

There is one major disadvantage to using GOSIP now. The MSE PSN internetworking capability for tactical area communications cannot be used with GOSIP, since GOSIP has a different internetworking protocol (CLNP) than the DoD protocol suite (IP). Access to the MSE PSN will still be possible using a direct interface to the tactical LAN.

8. Assessment

Additional work is needed to provide all of the eight military features identified by the nations in TSGCE SG9 (regrouped as five military issues by the DTMP): mobile hosts

and multihomed systems, multi-endpoint connection, internetworking, network and system management, security, robustness and quality of service, precedence and preemption, and real-time and tactical communications. Internetworking has now been addressed in OSI and additional work on support for relays is ongoing. Security services have been added to MHS and are reflected in the ISO and CCITT standards. OSI network management standards have now reached DIS status. The United States has released most of the security protocols developed in the SDNS program; SP3 and SP4 are being considered in ISO, and SP3 together with similar protocols developed in other nations is being considered in NATO (TSGCE SG9's AHWG on Security). However, a major program of work still remains to understand how best to promote the required services in ISO and CCITT and what can be done to enhance OSI services without interfering with interoperability stemming from use of the base standards. Multipeer data transmission (for net radio), quality of service (for requesting and ensuring delivery of required response times), and security are the major areas of concern.

More work is needed in the United States to understand how to make maximum use of OSI protocols (such as those mandated in U.S. GOSIP) for military systems, particularly for tactical systems. The ITDN demonstration with BLACKER and X.25 was an important milestone in this regard. The work of the PSSG and the DTMP has not yet resulted in implementable recommendations that go beyond use of GOSIP 1.0 that is currently mandated. Since both GOSIP 1.0 and 2.0 require MHS-84 for GOSIP conformance, there is a technical issue about how to achieve backwards compatibility with current ISO/CCITT standards (based on MHS-88, which provides security and other services not available in MHS-84)). The CCITT 1988 MHS Recommendation is scheduled to be included in GOSIP Version 3.0 [PSTP 1991].

Implementation of OSI protocols in military systems is slowly evolving. It appears that for most of the 1990s, WAM and other CCISs will need to support mixed stacks of (U.S. DoD and OSI) protocols to maintain interoperability with fielded and emerging systems. Robust stacks of OSI protocols may not be sufficiently widely implemented by 1995 that WAM can rely solely on OSI protocols.

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